Australasian Plant Conservation

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Abstracts of papers presented at the Mulgoa conference (second batch)

Managing Watsonia invasion in the threatened plant communities of south-west Australia's clay-based wetlands

Community-based monitoring: exploring the involvement of Friends Groups in a terrestrial park management context

Revegetation: the role of quality small sites

Flowering and seed production in the endangered Spiny Daisy, *Acanthocladium dockeri*

A toolkit for conservation on private land: winning hearts and minds

And much much more…

SPECIAL THEMES: TACKLING THE THREATS (continued); WOODLANDS

This issue

Regular Features

Australasian Plant Conservation

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ANPC Inc.
Mission Statement

"To promote and improve plant conservation"

Contributing to *Australasian Plant Conservation*

Australasian Plant Conservation is a forum for information exchange for all those involved in plant conservation: please use it to share your work with others. Articles, information snippets, details of new publications or research, and diary dates are welcome. **The deadline for the September–November 2008 issue is Friday 5 September 2008.** The theme of the September–November issue will be 'Assessing extinction risk: documenting the conservation status of Australian plants'. General articles are also very welcome. Please contact Rosemary Purdie if you are intending to submit an article: Rosemary.Purdie@environment.gov.au.

Authors are encouraged to submit images with articles or information. Please submit images as clear prints, slides, drawings, or in electronic format. Electronic images need to be at least 300 dpi resolution, submitted in at least the size that they are to be published, in tif, jpg or gif format. Guidelines for authors are at: http://www.anpc.asn.au/anpc/pdffiles/APCGuideContrib.pdf.

Please send articles, no more than 1100 words, as a MS Word (2000 compatible) or rich text format file, on disk or by email to: Rosemary.Purdie@environment.gov.au.

Front cover: Red Morrel (*Eucalyptus longicornis*) woodland near Harrismith, WA. Photo: Helena Mills/WWF
Cover design: Siobhan Duffy.
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From the Editor

Rosemary Purdie

c/- Centre for Plant Biodiversity Research, Canberra

This issue of *Australasian Plant Conservation* (APC) contains the remaining abstracts from ANPC's 7th National Conference *Our declining flora – tackling the treats*, held in Mulgoa, NSW on 21-24 April 2008, and four papers (on pages 10-15) from the conference.

The additional theme of the issue is "Woodlands", a plant community type that is threatened in many parts of Australia, especially in agricultural areas in the south. The articles cover woodlands in south-west Western Australia and south-eastern Australia. The topics include describing tools to help landholders manage their woodland vegetation, perceptions of woodlands, and woodland conservation status.

The issue concludes with a translocation case study from Victoria, two articles on projects to help conserve plants in tropical north Queensland, and our regular features.

Looking ahead, *APC 17(2), September–November 2008* will focus on how the national and state/territory governments in Australia go about assessing the extinction risk of native plant species. This is an important process to understand, as listing under state and territory threatened species laws brings with it responsibilities to address threats to the survival of such plants, and often provides funding opportunities for on-ground conservation works.

The theme of *APC 17(3) December 2008–February 2009* will be 'Trials and errors', to allow us to focus on a side of plant conservation that usually doesn't get much column space. Despite our best aims and planning for on-ground conservation activities, things can still go wrong (or not entirely as we had wanted them to) or we can get unexpected, perverse outcomes.

Examples that come to mind include: "we removed all the woody weeds but didn't anticipate we'd create an 'oasis' for rabbits" … "we set up our monitoring plots, and the results are still in the head of the person who now works overseas" … "we marked each plant with a tag and they've all disappeared" … "we thought we'd nailed the experimental design but it didn't work" … and so forth. Each time something like this happens, we often think the activity/trial/program was unsuccessful, but in reality we learn from it and try to avoid making the same mistake or attempt to 'do it better' the next time.

We are going to focus on these 'trial and error' types of things in APC 17(3) as a way of sharing what individuals or project teams have learnt from 'bitter' or 'rueful' experience, to help others avoid the same problem. It can be a short note or a full article – the choice is yours – and it's all part of adaptive management in on-ground plant conservation.

So, if you have a 'trial or error' learning that you'd like to share with other ANPC members, contact 'Trials and errors' coordinator Michael Vyse (phone 02 9585 6920; email michael.vyse@environment.nsw.gov.au) and let him know. All you need to think about is: the title of the project/activity; what worked, what didn't and why, and what were the main lessons learnt?

DATES FOR YOUR DIARY

ANPC Annual General Meeting

12:30-1:30 pm, Friday 28 November, 2008

Dickson Room, Australian National Botanic Gardens, Canberra

For those not located in Canberra, please plan to attend by phone hookup. Further details about the AGM will be provided in the next issue of APC.

ANPC Forum: *Off-reserve conservation*

April 29 to 1 May, 2009 at Halls Gap, Victoria

The role of private landholders and local community members has been, and will continue to be, fundamental in achieving successful conservation outcomes for species and ecological communities that occur outside Australia's reserve system.

The forum will bring together landholders, land managers, volunteers and scientists to discuss management and conservation of biodiversity on private land. It will include two days of presentations and opportunities for discussion, and an optional third day of sightseeing within the spectacular Grampians National Park and surrounds, including an example of a successful grassland restoration project on a private property.

Abstracts of papers (second batch) presented at the ANPC Seventh National Conference: Our declining flora – tackling the threats 21-24 April 2008, Mulgoa NSW

Statistical analysis of floristic plot data to identify, define and describe vegetation communities to assist in their nomination as Threatened Ecological Communities under the NSW TSC Act 1995

Penny Kendall and Brett Snelson

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This paper outlines the methodology developed to define and describe floristic communities as part of the Threatened Ecological Communities (TEC) nomination process. The nominations were based on rare, endangered or vulnerable Forest Ecosystems identified during the North East Comprehensive Regional Assessment (NPWS 1999). The targeted Forest Ecosystems were dominated by *Eucalyptus fastigata*, *E. viminalis* and/or *E. nobilis.* These targeted Forest Ecosystems which had been poorly defined and described firstly needed to be confirmed as ecological communities. Floristic plot data was analysed using a combination of PATN, Excel and Arcview as an aid to investigate, explore and describe the communities. PATN software was used to undertake a numerical statistical analysis of floristic plot data. Bray Curtis association and flexible UPGMA classification was used to test the validity of and re-define a suite of forest ecosystems, a fidelity analysis using Excel was developed to identify indicative species and describe the floristic content of the communities. Arcview was used to investigate the spatial relationships and abiotic attributes of the PATN groups. The analysis supported the nominations by identifying discrete communities, assisting in determining floristic composition and indicating the range of abiotic attributes for the community. The methodology also providing reference plots considered indicative of the community. Although this methodology has been developed for the nomination process it is equally applicable to existing TECs where it could assist in their definition and identification.

Seed longevity can be changed by the pre-zygotic parental environment

Jitka Kochanek[1], Katherine J. Steadman[2], Robin J. Probert[3] and Steve W. Adkins[1]

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Understanding seed longevity is important for *ex situ* seedbanks that aim to conserve plant diversity and possibly also for explaining soil seedbank persistence. Thus, if seed longevity is compromised by climate change, biodiversity may also be reduced.

This paper reports a glasshouse study that investigated the effects of the pre-zygotic parental growth environment on offspring seed longevity. Two Australian native species, *Wahlenbergia tumidifructa* P. J. Sm. (Campanulaceae) and *Plantago cunninghamii* Decne. (Plantaginaceae), were grown under two soil moisture levels (wet, -0.01 MPa; dry, dried to -1 MPa, rewatered to -0.1 MPa) within two temperature regimes (high, 33/28 ± 5 °C; low, 18/13 ± 5 °C) throughout the pre-zygotic development phase. The seeds were harvested at physiological maturity, processed and the seed longevity determined. The parental phenotype was also described.

Seed longevity was affected by the parental environment for both species. However, the species reacted differently to the environments imposed. High temperatures halved the seed longevity for both species, but drought halved seed longevity only for *W. tumidifructa* and had no effect on *P. cunninghamii*. Also for *W. tumidifructa* high temperatures resulted in smaller plants that reproduced sooner and the corresponding seed-lots deteriorated more rapidly. These findings may be particularly relevant in the context of climate change since high temperatures and/or dry pre-zygotic conditions reduced the seed longevity for both species.

Native grasslands on Victoria's Northern Plains – past, present and future trends in loss, management and conservation

Deanna Marshall and James Fitzsimons

See Marshall and Fitzsimons in APC 16(4), pp 24-25.

What are conservation management networks?

Toni McLeish

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Conservation Management Networks (CMNs) are an emerging approach that can contribute significantly to achievement of Australia's conservation priorities. Drawing the best from local communities, they represent a cost-effective way of tackling difficult issues across both private and public land. CMN's enhance the existing public protected area estate by increasing the potential linkages in the landscape and therefore the viability of individual public protected areas.

A Conservation Management Network is an umbrella group of public and private land owners, and other interested individuals, who work together to manage areas of native vegetation for biodiversity outcomes. CMNs usually focus on one ecological community (e.g. Box Ironbark CMN) because the management needs of remnants from one community are usually similar, although one covers all threatened vegetation in a single geographical area (e.g. Bega Valley CMN). Remnants in a CMN are not controlled or purchased by a centralised agency. Rather, existing owner/managers are encouraged to join the CMN which provides a link to best management practices and to continue to protect and/or manage their remnant as it has been in the past or with increased focus on conservation values.

CMNs are the only network specifically focusing on remnant vegetation across a range of land tenures. The majority of members live and work in the area so CMN projects are a true reflection of what the community needs and wants.

Assessing translocation success for the critically endangered *Lambertia orbifolia* subsp. *orbifolia*

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Translocation, the deliberate transfer of plant regenerative material from one area to another for conservation purposes (Vallee *et al.* 2004), is still in its infancy as a management tool in Australia. The goal of translocation is to establish viable, self-sustaining populations (Guerrant 1996). The difficulty is in setting goals that enable realistic assessment of whether the translocated population will be able to persist in the long-term. In Western Australia many of the species with translocation programs are long-lived woody perennials with life cycles linked to disturbance events, such as fire. With long intervals between generations there is a need for a methodology that enables us to predict the likelihood of the new population being able to persist. Combined with criteria such as survival, growth and reproduction of the new population, we have used mating system analysis to predict whether the translocation of *Lambertia orbifolia* subsp. *orbifolia* is likely to be successful. *L. orbifolia* subsp. *orbifolia* is a critically endangered large woody shrub confined to three populations in south-western Australia. Translocation to a new secure location was seen as an essential action to assist in the recovery of the taxon. The translocation also allowed for the experimental testing and refinement of establishment techniques for future translocations of this and other taxa. Short- and long-term success criteria were formulated to assess whether the translocation was likely to result in a viable self-sustaining population. Short-term criteria, such as the survival of plants, production of flowers and viable seed as well as natural recruitment of second generation plants have all been met six years after translocation commenced. The potential for persistence of the new population in the long-term was assessed using mating system analysis and comparing this with the parameters found in the natural populations of this taxon.

Good, Better, Best – key components for successful habitat reconstruction in native plant communities – post open cut coal mining

Dee Murdoch

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Continuous learning, high commitment to knowledge and skill sharing among all stakeholders are the key factors for land management success at open cut coal mines, as demonstrated in the Hunter Valley.

The old saying "Good, better, best – you can't afford to rest until your good is better and your better is best" is nowhere more pertinent than in land stewardship at open cut mines. Mines in the Hunter Valley have developed and implemented a high degree of innovative natural resource management techniques to meet the community expectations in standards of excellence in community liaison and rehabilitation skills. Experience gained at a wide cross-section of open cut coal mines across the Hunter Valley shows that there are often no 'clear cut' solutions to habitat reconstruction and mine site rehabilitation; hence the need for continuous learning and sharing.

The development of innovative NRM practices has been in response to mining operations' Consent Conditions that provide the framework under which they operate. The Conditions have been developed on the realisation that the industry is self regulating and are aligned to risk management and environmental processes. The development of the Consent Conditions is also closely linked to community expectations. These relate to the establishment of sustainable post mining native plant communities, and are an open exchange of information between all stakeholders based on industry leading practice with regards to land rehabilitation.

The paper gives a detailed review of four key NRM practices including monitoring, timber management, seed collection, weed and vertebrate pest management

and control and makes special note of two other issues including ecologically diverse communities and the future of habitat reconstruction.

Eucalypt dieback: An increasing threat in rural landscapes?

Chris Nadolny

See Nadolny in APC 16(4), pp 26-27.

Holsworthy Army Barracks revegetation research

Hazel Nisbet[1] and Lee Chesterfield[2]

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Holsworthy Army Barracks, near Liverpool, NSW, has cleared native vegetation to enable the construction of buildings and development to increase the capability of a number of new Defence facilities in Western Sydney. In line with Defence Strategic Policy the strategic importance of Holsworthy Barracks has increased. To enable the required increase in capability, a number of new facilities are being constructed to increase the Australian Defence Force's (ADF's) effectiveness in training and operations.

Holsworthy Barracks contains a good representation of endangered ecological communities (EEC) which are also threatened by fire and weeds. Recent expansion has required the clearing of approximately 11 ha of EEC land and approximately 20 ha of cleared land/scattered trees. ENSR Australia (formerly HLA-Envirosciences) was commissioned by Defence to establish a Greening Plan to help offset the loss of EEC and other vegetation communities. 32 ha of land was selected for revegetation and rehabilitation works following liaison with Defence to ensure areas are protected.

Soil and vegetation sites and photo monitoring locations were established in cleared areas and control (analogue) sites. Seed and cuttings were collected from the site. Revegetation plans were established for each of the areas and these were subject to removal of waste materials, unexploded ordnance and cultural clearance. Revegetation trials have been incorporated into the revegetation at Holsworthy to research methods of tubestock planting and direct seeding and surface preparations. Seeding and tubestock trials are planned for autumn 2008 with broadscale planting in 2009.

How a national strategy for *ex situ* plant conservation in Australia can deliver a roadmap to tackle the threats facing our flora

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The Australian Seed Conservation and Research (AuSCaR) partners are responding to the impact of threatening processes on plant diversity by demonstrating a series of positive practical actions. Funding through the Millennium Seed Bank Project, Kew, acted as a catalyst to the engagement of botanic gardens, conservation agencies and universities in every state and the Northern Territory which led to the formation of a nascent Australian Seed Conservation and Research network. This has seen an increase in activity that has built the capacity of partners to carry out *ex situ* conservation and an aligning of partnership goals towards meeting Australia's obligations to Target 8 of the Global Strategy for Plant Conservation, "*60% of threatened species in accessible ex-situ collections, preferably in the country of origin, and 10% of them included in recovery and restoration programmes.*". The current AuSCaR partnership is providing a national approach to addressing plant diversity decline through the use of seed banking technologies and subsequent *in situ* recovery methodologies. The implementation of a national strategy for *ex situ* plant conservation, currently being developed, will allow Australia to work towards "no species loss" of its seed bearing flora.

The plan for tackling Phytophthora in NSW

*David O'Toole, Linda Bell, Alison Schumacher and *Samantha Hampton*

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**Formerly with same organisation*

A framework has been developed guiding the implementation of the NSW Department of Environment and Climate Change (DECC) threat abatement program addressing 'Infection of native plants by *Phytophthora cinnamomi*' in NSW.

This Statement of Intent describes the nature of the threat, the key challenges and outlines DECC's approach to implementing a broad program of actions over the next 5 years to manage the threat and minimise the impact of *Phytophthora cinnamomi* on the biodiversity of NSW. It is designed to be used as a resource for DECC staff, other interested NSW landholders and land managers.

How local is local? Local adaptation and outbreeding depression in fragmented plant populations of *Rutidosis leptorrhynchoides* (Asteraceae)

Melinda Pickup[1,2,3] and Andrew Young[1]

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[2]Australian National University, Canberra.
[3]Greening Australia Capital Region, Jamison, ACT.

Provenance, local adaptation and outbreeding depression are important genetic issues in the restoration of threatened plant species and the delineation of appropriate seed sourcing zones for revegetation. *Rutidosis leptorrhynchoides* is an endangered perennial herb endemic to the grasslands and grassy woodlands of South-Eastern Australia and is an

ideal species to examine local adaptation and outbreeding depression in relation to spatial scale, population size, environmental distance between populations and the potential benefits of genetic rescue for small populations. Local adaptation and outbreeding depression were assessed using both transplant and crossing experiments that involved 18 population pairs separated by a range of distances from 0.7 – 600 km. For the crossing experiment, F1, F2, F3 and control (within local population) offspring were generated for 12 of the 18 population pairs. The difference between the control (within local population cross) and F1, F2 and F3 progeny were then compared for a range of traits across the lifecycle. There was no consistent evidence of local adaptation across a range of fitness traits, with equivalent performance of local and foreign plants in most population pairs. For the majority of population pairs in the outbreeding depression experiment, the fitness of inter-population hybrids was either equal to or greater than the local population for a range of fitness traits across the lifecycle (i.e. heterosis). Population size was found to be a key predictor of hybrid fitness, with the greatest increase in progeny fitness in population pairs with small local and large source populations. Crossing between populations was also found to increase mate availability and reproductive success in small populations. The results of this study suggests that the introduction of new genetic material can result in a two-fold benefit for small *R. leptorrhynchoides* populations, firstly by increasing mate availability and secondly through increased fitness due to heterosis.

A grand vision – landscape connectivity in the NSW great eastern ranges

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The Alps to Atherton (A2A) initiative is aimed at strengthening the resilience of the biodiversity within the great eastern ranges of Australia in the face of threatening processes including fragmentation and climate change. Within NSW, A2A has established several pilot areas, including the Kosciuszko to Coast and Slopes to Summit areas in the south of the state. These pilot areas are demonstrating the principles of the broader A2A vision, including establishing partnerships and applying voluntary mechanisms in a targeted way, to deliver on-ground conservation outcomes. The corridor is based on the core areas provided by national parks and nature reserves that run in a chain between the Victorian and Queensland borders and will be augmented by private reserves, covenants, incentive and stewardship payments and other off-reserve mechanisms to strengthen north-south and east-west links. The A2A program is funded by a NSW Environmental Trust Major Programs Grant.

Successes and failures across the ditch – can a New Zealand Network really tackle the threats?

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The New Zealand Plant Conservation Network was formed in April 2003 as a sister to the ANPC. In five years the Network's membership has grown to more than 500 paying members. The Network website (www.nzpcn.org.nz) receives over half a million visits each year.

The Network implements the Global Strategy for Plant Conservation by a Conservation assessment of native species (Target 2), identification of Important Plant Areas (Target 5), the establishment of a national threatened plant seed bank (Target 8) and the development of five training modules (Target 15). Other initiatives include a monthly newsletter read by over 2000 people, an annual poll to find New Zealand's favourite plant and an annual awards ceremony to recognise achievements of those working in plant conservation.

Kiwi ingenuity combined with a passion for conserving native plants amongst members of the Network, and staff at the Department of Conservation, are key ingredients in New Zealand's partially successful implementation of the Global Strategy. Barriers to more rapid progress still exist. Adequate legal protection for native plants remains elusive. Climate change has won the battle for media attention whilst other environmental issues are relegated to good news sound bites. Wild natives continue to be swamped by naturalised species whilst pressure increases to relax border biosecurity controls further. Many people's knowledge of native plants is criminally poor ('the Norfolk pine is native, isn't it?') Indigenous plant communities often fare second best when developments beckon. Most importantly, a majority of New Zealanders believe the health of their natural environment to be 'good' or 'very good'. Meanwhile, this year saw a threefold increase in the number of critically threatened native plant species – our flora is in serious decline. A new strategy is urgently needed and will be presented.

A wetland rehabilitation prioritisation technique developed for the Sydney Metropolitan Catchment Management Area

Liza Schaeper

See Schaeper in APC 16(4), pp 28-30.

Conservation Incentives Program (CIP) in NSW

Xuela Sledge

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The Conservation Incentives Program (CIP) is a Million dollar Department of Environment and Climate Change (DECC) initiative funded by the Hawkesbury Nepean Catchment Management Authority (NHT funding) for the restoration of Endangered Ecological Communities and threatened species habitat. The majority of the lands involved in this Program have been privately owned, with 75% of this funding being dedicated to western Sydney's Cumberland Plain. The rest of the funding has been spread across the catchment.

Outcomes of the Program have been very successful with work on several of the vegetation communities associated to the Cumberland Plain. Bush regeneration has been the focus of activities on the Plain, with survey work being a major activity for threatened species. Whilst regional trends in threatening weeds have appeared, and bush regeneration lessons learnt, networking and empowering private individuals across the landscape to carry on maintenance of their projects when the funding finishes has proven advantageous for the disappearing habitats associated. Particular successes have come from the Kurrajong and Razorback areas, where energy was dedicated to restoration of Western Sydney Dry Rainforest. These and other focus areas came from DECC priority areas, where significant tracts of vegetation still existed, thought to be most suitable for benefiting to conservation incentives funding.

The presentation is about private land conservation, the lessons learnt and, the real possibility of attaining land in valuable western Sydney to restore the Cumberland Plain.

The importance of understanding genetic diversity in ecological restoration – a case study on *Wilsonia backhousei* (Convolvulaceae)

Karen Sommerville[1], Maurizio Rossetto[2] and Alex Pulkownik[3]

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The erosion of genetic diversity through habitat fragmentation is a concern for all plant species, but is of particular concern for species in urban saltmarsh ecosystems. In these areas, any increase in sea-level caused by warming of the climate will lead to an increase in the frequency of tidal inundation and subsequent changes in soil water content, salinity and chemistry. In undisturbed environments, saltmarsh species may migrate inland to escape the changing conditions; in urban areas, where any escape route may be cut off by development, they are dependent on the maintenance of genetic diversity to enable adaptation.

We investigated genetic diversity and structure in selected populations of the clonal saltmarsh plant *Wilsonia backhousei* (Convolvulaceae) in order to develop guidelines for maximising diversity in remnant and restored populations of the species. Using microsatellite primers designed for the purpose, we found that:

- A single clone could cover an area of up to 225 m^2
- The number of clones per site was not directly related to site size, nor was the level of genetic diversity
- Sites with only a few clones were not visually distinguishable from sites with many
- Seed production was rare or nonexistent at sites containing only a single clone, or several very closely related clones
- Gene flow occurred by tidal dispersal of seed (no vegetative dispersal among sites was detected) and was largely limited to within an estuary.

The implications of these results, for past and future restoration efforts for the species, will be discussed.

Plant diversity in the paddock: managing native pastures for biodiversity

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A significant range of native plant species still persist in grazed paddocks across the Murray Darling Basin. With around 3 million hectares of native pastures currently being used for sheep and cattle production, grazing management is critical to the persistence of these native grassy woodland plants. What management actions will have the most influence on the persistence of these plant species over time? Many land managers are moving away from set stocking to a mix of rotational grazing regimes, where high numbers of stock are grazed in smaller paddocks for short periods of time. It is generally acknowledged that farm productivity can be improved by as much as 25% by these changes but are there any biodiversity benefits? The emerging story from recent research indicates these different grazing regimes may not be as influential as other management factors such as superphosphate application, stocking rate and amount of tree cover. Based on these results a management guidelines booklet for land managers is currently in development, to provide accessible information and best practice guidelines for maintaining biodiversity in conjunction with farm productivity. Management actions, such as identifying suitable paddocks for higher inputs and reducing fertiliser on areas of native pastures with good species diversity, can benefit more sensitive species. Ensuring stocking rate is matched to carrying capacity, targeting low fertility areas with scattered trees for encouraging eucalypt regeneration and maintaining tree cover will help retain native plant diversity in paddocks over time.

Survey and management of Phytophthora cinnamomi within NSW

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Phytophthora cinnamomi is a soil borne root pathogen responsible for dieback disease epidemics occurring throughout Australian native plant communities. Infection of native plants by *P. cinnamomi* has been listed as a key threatening process on Schedule 3 of the NSW Threatened Species Conservation Act 1995 and under the Australian Government's Environmental Protection and Biodiversity Conservation Act 1999. The delicate ecological balance of natural ecosystems is disrupted when this pathogen kills susceptible plant species, altering species composition with subsequent losses of food and habitat for native fauna.

Although *P. cinnamomi* has been widely studied throughout much of Australia, its occurrence and distribution in many areas of NSW that are regarded as having high conservation value remains unknown. The Botanic Gardens Trust, Sydney is coordinating two projects that will address some of these gaps in our knowledge.

The projects involve surveying and mapping the distribution of *P. cinnamomi* within native bushland regions of the Sydney Metropolitan and Hawkesbury Nepean catchment regions, undertaking glasshouse trials to assess the susceptibility of selected NSW plant species to dieback disease, developing educational materials and conducting *Phytophthora* awareness seminars to disperse this information to land managers and users. The information gained from these projects will ultimately lead to better management practices for *Phytophthora* in the Sydney and Hawkesbury Nepean Catchment areas and provide a framework for its management in native ecosystems throughout NSW.

Threats and responses at the ecological community scale

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Historically, biodiversity conservation efforts have focused on sites and species. In this talk, we consider the more recent development of an ecological community approach to conservation, and the additional benefits this offers. Ecological communities, like human communities, are complex things both to define and to grasp. They intergrade, they cross jurisdictions and they interdigitate across landscapes. Nevertheless, conservation planning at this scale is extremely valuable: conserve an ecological community and you conserve most of its component species and a wide range of associated ecological and evolutionary processes. At regional and national scales, a conservation framework based on ecological communities promotes more comprehensive conservation outcomes.

In intact landscapes, conservation of ecological communities can be achieved through appropriate reserve planning. In degraded and fragmented landscapes however, conserving ecological communities becomes challenging indeed. In temperate agricultural landscapes of south-eastern Australia for example, many ecological communities remain only as a series of small, widely scattered and often degraded remnants within an agricultural matrix. To help overcome these challenges, new conservation models have been established. For example, the Conservation Management Network model promotes coordination, communication, knowledge transfer and support across the many land tenures and land managers involved in a particular ecological community.

To conclude, we emphasize the importance of getting the balance right. Approaching conservation from species and site scales is important, but for optimal outcomes at regional and national scales this needs to be combined with an ecological community view.

Responding nationally to the Key Threatening Process of lantana invasion

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Lantana camara L. (lantana) is a Weed of National Significance and in NSW, the invasion, establishment and spread of lantana has been listed as a Key Threatening Process under the NSW *Threatened Species Conservation Act 1995*. As a response to this, a new national plan for managing lantana for biodiversity conservation is being jointly developed by the NSW Department of Environment and Climate Change and Biosecurity Queensland. This plan establishes the management priorities for lantana with respect to protecting biodiversity within Australia. The goal of this plan is to minimise the threat of lantana on biodiversity by protecting listed threatened native species and ecological communities and preventing further species and ecological communities from becoming listed as threatened. Determining the biodiversity threatened by lantana is a critical step for the development of this plan, especially as this widespread alien species is unlikely to be eradicated. Using the Weed Impacts to Native Species assessment tool, 269 native plant species which are listed or have the potential to be listed under Commonwealth or the relevant State's threatened species legislation are also at risk from lantana. As lantana has invaded large areas encompassing many diverse ecological communities, it was essential to identify the biodiversity at risk and then to identify the invaded sites and prioritise them based on the level of threat and the likelihood of reducing the threat of lantana at each site. This two-step process is essential for targeting control to areas where the benefits to biodiversity are the greatest.

Landscape genetics of five common Austrodanthonia species in central western NSW

Cathy Waters and Surrey Jacobs

See Waters in APC 16(4), pp 31-32.

Developing regional priorities for the management of weed threats to native plants

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Despite widespread acknowledgement that weeds pose a major threat to biodiversity, regional weed management for biodiversity conservation has often been hampered by a lack of strategic direction and expertise. This has led to: programs that do not necessarily deliver biodiversity outcomes; ineffective monitoring systems; "gaps" in funding; and a lack of long-term commitment (i.e. over sufficient time to measure a biodiversity response). To help resolve these problems in NSW, one of the Natural Resources Commission's biodiversity targets is specifically aimed at invasive species (weeds and pests). These targets are aimed at the 13 natural renouncement management regions in NSW (or Catchment Management Authorities - CMA). To meet this target by 2015, regional weed control programs need to be developed and implemented now.

In April 2007 a project commenced to prioritise weed control for conservation of biodiversity within each of the 13 CMAs using a standardised methodology. The process identifies:

- weeds posing a threat to biodiversity in each CMA;
- biodiversity most at risk from those weeds (being vegetation communities and plant and animal species);
- sites at which control will have the greatest biodiversity benefit (i.e. to the biodiversity identified in 2.); and
- biological monitoring required to report on progress towards the target.

This list of priority sites can then be used by each CMA to direct weed control funding over the next decade. The development of standard monitoring protocols will allow assessment of the performance of these weed control measures in meeting the biodiversity and invasive species target by 2015.

Managing Watsonia invasion in the threatened plant communities of south-west Australia's clay-based wetlands

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The Seasonal Clay-based Wetlands of South-west Australia

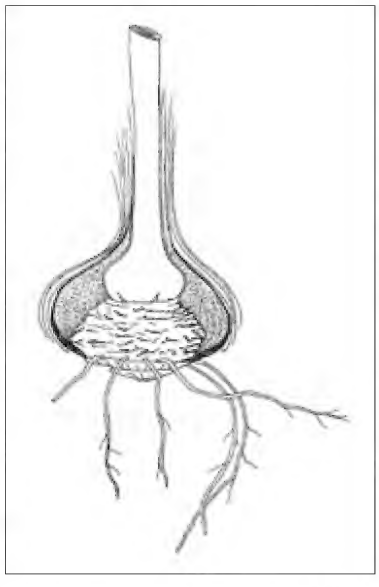
While the majority of seasonal wetlands in south-west Australia are connected to the regional ground water, some are found on clay substrates that rely solely on rainwater to fill. These wetlands are characterised by temporally overlapping suites of annual herbs that flower and set seed as the wetlands dry through spring. Over summer the clay substrates dry to impervious pans. The plant communities of clay-based wetlands comprise a flora of over 600 species, of which at least 50% are annual or perennial herbs, 16 occur only on the clay-pans and many are rare or restricted.

The seasonally inundated clays that support these communities are relatively productive agricultural soils and many were cleared soon after settlement. Those that remained intact were largely located on the Swan Coastal Plain in close proximity to metropolitan Perth. In more recent years large areas have disappeared under urban development and today the plant communities of seasonal clay-based wetlands are amongst the most threatened in Western Australia.

The small and fragmented nature of these remaining wetlands leaves them vulnerable to a range of threatening processes. Weed invasion by the South African geophyte Watsonia (*Watsonia meriana* var. *bulbillifera*) is a major threat. Watsonia can disperse via cormels (tiny corms that develop along the flowering stem at the end of the flowering season), into relatively undisturbed bushland remnants, forming dense stands (Fig. 1) that effectively displace the diverse herbaceous understorey.

Study Site and Field Methods

Meelon Nature Reserve, a remnant clay-based wetland on the eastern side of the Swan Coastal Plain 200 km south of Perth, has been the focus of a three year study investigating possible management techniques for Watsonia where it is invading these communities. We specifically investigated the effectiveness of the herbicide 2-2DPA (Dalapon®, Propon®) in controlling populations of Watsonia, and also examined the impacts of the herbicide on native flora of a clay-based wetland, the response of the native plant community to Watsonia removal and then the compounding impacts of fire on the regeneration process.



Left to right: Figure 1. Watsonia invading the clay-based wetlands of Meelon Nature Reserve. Photo: Kate Brown Figure 2. Corm exhaustion in Watsonia. Illustration: Libby Sandiford. Figure 3. Tribonanthes australis. *Photo Kate Brown*

In August 2005 before the herbicide trials were established, the density of Watsonia across the reserve was mapped. Five permanently marked transects were then established in an area where the cover of Watsonia was estimated to be greater than 75%. Thirty 1 m x 1 m quadrats were placed along the five transects and the cover of all native and introduced taxa recorded.

The herbicide 2-2DPA (10g/L) + the penentrant Pulse® (2.5 mL/L) was applied from a backpack unit in September 2005. Herbicide application on invasive geophytes such as Watsonia should take place just as the underground storage organ is exhausted and this often coincides with flowering. For Watsonia in south-west Australia, corm exhaustion (Fig. 2) generally occurs in September.

Results

One year after the initial treatment, a 97% reduction in the cover of Watsonia was recorded and importantly there was little evidence of serious off-target herbicide damage to the native flora. The cover of some native species had decreased but none were lost. The herbicide treatment was followed up in September 2006 on the few Watsonia plants left.

The following summer, February 2007, an unplanned wild fire burnt across the reserve and through the study area. In September 2007 a significant increase in the cover and diversity of native species was recorded across the site. Some species such as *Dichopogon preissii* had not been recorded at all before the fire. Others, such as the native sedges *Cyathochaeta avenacea* and *Chorizandra enodis*, and a number of native geophytes including *Chamaescilla gibsonii*, *Tribonanthes australis* (Fig. 3) and *Burchardia multiflora* increased greatly in cover following the fire.

Importantly, the cover of Watsonia had been reduced from greater than 70% in 2005 to less than 1% by 2007 and there was no resprouting or recruitment from cormels or seed following the fire.

Conclusions

The fire was an unplanned event and burnt across the entire study site. It is therefore difficult to separate the effects of Watsonia control from the effects of the wildfire. Nevertheless it seems clear that 2-2DPA was effective at controlling Watsonia, that the off-target damage to native flora was not significant and that fire then triggered regeneration of the native plant community through germination of the soil seed bank and resprouting of various storage organs.

These initial results are promising for management of Watsonia invasions in these clay-based wetlands. Indications are that once Watsonia has been killed the communities have the capacity to regenerate, with fire potentially playing a significant role in the process.

A Word of Warning

While fire could be a useful tool in the restoration of clay-based wetlands it is also probable that it plays a significant role in the invasion of Watsonia into these plant communities in the first place. There is evidence from South Africa, where Watsonia occurs naturally, that plants flower particularly well following fire. This leads to prolific cormel or seed production. The cormels are produced towards the end of the first growing season after fire and then germinate *en masse* with the first autumn rains of the second season. In the parts of Meelon Nature Reserve outside our study area where Watsonia had not been controlled, we observed prolific flowering following the fire. It will be interesting to see if this leads to recruitment in our study area in 2008. Fire should only be considered as a management tool where Watsonia control has been comprehensive and complete across sites.

Spreading the Word

The study has been a collective effort involving staff from across the Department of Environment and Conservation and members of the local Dwellingup community. In September 2007 a workshop and field day was run in conjunction with the Waroona Land Care Centre for land managers in the region. The day provided the opportunity to share the results of our work and to provide advice to local landholders, many closely involved in the management of plant communities associated with clay-based wetlands.

Further Reading

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Community-based monitoring: exploring the involvement of Friends Groups in a terrestrial park management context

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Study Background

Environmental monitoring is a critical tool for informing the management of Victoria's public parks and reserves. It provides base knowledge of both the natural assets and the threats which confront our protected area system. Monitoring also helps to identify changes in the park landscape and determine the success of park management activities. Globally, monitoring activities conducted by volunteers have proved accurate data can be obtained, and this data can be extremely useful in informing management actions. Moreover, Community-Based Monitoring (CBM) can foster a sense of ownership of natural areas amongst participating volunteers, raising awareness of environmental issues and leading to improved bonds between community members and decision makers. Volunteers often have unique local knowledge which can be valuable for monitoring activities. However, the skills possessed by monitoring participants must be of a sufficient standard to ensure the data collected is accurate enough to achieve its desired management outcome.

The presence of over 120 Friends Groups associated with state and national parks in Victoria provides an avenue for volunteer involvement in CBM. While some Friends Groups have been participating in CBM for some time, the scale of monitoring activities and their subsequent outcomes is not widely understood at a state wide management level.

Objectives

The objective of this research was to explore how Friends Group monitoring activities contribute to park management, using terrestrial-based Friends Groups in Victoria as a case study. To achieve this objective the following research aims where identified:

- exploring the current state of CBM conducted by Friends Groups;
- investigating the relationship between Friends Groups and rangers regarding CBM; and
- identifying a potential framework for CBM programs within terrestrial parks.

Study Design

To complete this study, 11 individual volunteers from a range of Friends Groups located across the state (Fig. 1) were interviewed about their participation and experience of CBM activities. These groups were selected initially by acquiring from Parks Victoria a list of Friends Groups that had conducted monitoring in the last 12 months; five of these groups agreed to an interview. To ensure a range of groups from a variety of urban and rural parks were interviewed, the Victorian Friends Network website (http://home.vicnet.net.au/~friends/index.html) was used to select the remaining groups. To determine the opinions of Park Rangers towards CBM, the 87 Parks Victoria Rangers listed as having 'Community Liaison' responsibilities with community groups were sent a short questionnaire; 34 rangers responded to the survey.

Monitoring Activities

CBM activities have been widely adopted by Friends Groups across the state. Tasks varied from the monitoring of flora (threatened species, weed mapping, fixed-point

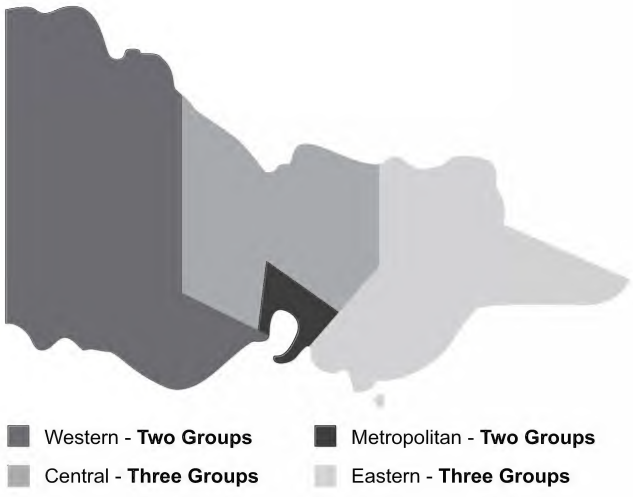

Figure 1. The number of Friends Groups selected for interviews from the various State and National Park regional areas of Victoria.

photography) and fauna (mammal trapping, nest boxes, bird surveys/mist netting, frog monitoring, lyrebird and koala counts), to water quality and ecological burns. Overall, the predominant monitoring focus was flora, specifically threatened species, mapping indigenous flora, and introduced weed species.

Social Networks

The strength of social networks between Friends Groups and other environmental community groups facilitated the sharing of knowledge and skills which benefited volunteer monitoring capacity. These networks often connected volunteers to industry professionals working in government agencies or herbaria that helped fill any knowledge gaps the groups possessed. As a result, data accuracy could be validated, which promoted a more positive view of the value of volunteer monitoring by Park Rangers in a number of cases.

Data Use & Accuracy

Of the 21 ranger questionnaire respondents who indicated CBM occurred in their park, 86% actually receive the data collected by the associated Friends Group. Moreover, 78% of rangers rated the accuracy of this data as either 'good' or 'excellent'. It is not surprising, therefore, that 79% of the Rangers receiving monitoring data are using it to inform park management in some capacity. Rangers identified a high level of competency amongst select volunteers, while some suggested such results were indicative of the degree of ranger involvement required in the completion of CBM tasks.

Role of the Individual

Highly motivated individuals were often the key to the continuity of monitoring projects. The task of recording and storing data, organising and motivating the other Friends Group members regularly falls to a small number of people. The greater the knowledge and skill requirement of a monitoring project, the fewer the number of members who were involved. However, even the simpler monitoring tasks, such as species counts, rarely involved the whole group at once.

Ranger Relationships

Volunteers felt rangers rarely had time to conduct monitoring activities, thus Friends Group participation helped fill a void in gathering baseline park knowledge. While rangers were generally very positive about CBM, some indicated volunteer monitoring often requires a time and resource commitment to assist volunteers in an organisational capacity. The nature of the relationship between Friends Groups and rangers had an impact on the range of volunteer activities in general, with open and regular communication fostering a mutual respect, often resulting in a more active Friends Group. Informal discussions over a cup of tea often proved more beneficial in terms of knowledge sharing and developing trust than formal or annual meetings.

Challenges

Friends Groups often confronted their own unique barriers to partaking in CBM, depending on local factors. However, common challenges included a declining and aging volunteer network, deficiencies in the requisite ecological knowledge and skills, a lack of clear monitoring objectives, maintaining motivation for monitoring over time, and receiving ongoing funding and management support for monitoring projects.

Of these common challenges, maintaining motivation seemed to permeate all the barriers which confront CBM. Friends Groups indicated that a lack of monitoring outcomes was directly linked with dwindling motivation. Previous CBM studies have identified that the use of photography as a means of visually capturing monitoring outcomes can be effective in maintaining volunteer motivation.

Recommendations for Improving CBM in Terrestrial Parks

- Monitoring training – focusing on flora and fauna training is a key priority, with an educational component so monitoring results are understood in the context of broader park management aims.
- Regional coordination – training support could be delivered by an external regional coordinator, easing some of the burden from local rangers, whilst also acting as collector for Friends Group monitoring data.
- Setting targets – monitoring projects must have clear and attainable goals, so volunteers can see the value of the task to their local park from the outset.
- Volunteer consultation – involving volunteers in developing monitoring projects may increase Friends Group ownership of CBM, enhancing motivation and improving project sustainability.

- Standardised methods – monitoring methods must be standardised for ongoing result consistency, making monitoring processes clear so projects have a greater chance of being sustained by others if key volunteer participants move on.
- Ranger communication – volunteers and rangers must continue to foster good relations if long-term monitoring projects are to be sustained.
- Monitoring outcomes – projects should have visually communicated outcomes to enable Friends Groups to easily track their progress, subsequently helping to maintain motivation. Fixed point photography should be considered as either a stand alone monitoring technique or a component of a wider CBM task wherever possible.
- Data sharing – a central internet-based database for data storage and retrieval, combined with an internet forum to exchange ideas, could help to facilitate greater knowledge-sharing between Friends Groups.

Revegetation: the role of quality small sites

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Introduction – Revegetation work in Burnside

The City of Burnside is a municipality of about 40,000 people between the Adelaide Central Business District and the foothills to the east. When Council adopted its Biodiversity Policy in 1996, there was little of the original natural environment remaining. So biodiversity management in Burnside has consisted of conserving remnants, and re-establishing local flora, at any available location where indigenous vegetation will fit into the urban landscape. Where only small areas are available, quantity of habitat is not an option. So we opted for quality. A focus on quality at small sites can provide lessons for improving revegetation quality at a larger scale.

Revegetation here refers to the establishment of local flora on sites where no or very few indigenous plants are evident. If we imagine a continuum of site quality from undisturbed native vegetation at one end, to completely degraded areas at the other, revegetation applies to sites at the degraded end of the continuum.

At a small scale, it is possible to direct more effort to a given area and quality can be achieved by making repeated visits to remove all weeds, to protect natural regeneration and to introduce appropriate local seeds and plants. The full potential of a site to regenerate naturally can then be realised and in time the planted and sown flora will also self-sow and spread. Working on small sites also allows vegetation workers to build local knowledge and improve the way the next small area is approached. In time, many small quality sites add up to a large area of functioning native vegetation. A large area revegetated all at once is at great risk of becoming a weedy plantation with high ongoing management costs.

Although the Bradley Method of bush regeneration (Bradley 1988) was developed in response to weeds invading good quality bushland, many of the principles and practices are applicable to developing quality native vegetation on very degraded sites. The main difference is that more botanical knowledge is needed before useful work can be done.

Example – Waterfall Gully Reserve

An example of this philosophy being put into practice is seen at Waterfall Gully Reserve, a 3 ha site consisting of a creek and floodplain surrounded by woody-weed dominated hillsides. Historically, the site was a market garden which was subsequently taken over by Willow, Ash, Blackberry and Kikuyu grass as well as many other introduced weeds. Indigenous flora scattered amongst the weeds include *Typha*, *Phragmites*, *Carex fascicularis* and *Juncus subsecundus*. The Burnside Biodiversity Volunteers, a group of about half a dozen regulars, were keen to find a riparian site that they could work on and this unmanaged Council reserve provided a promising location.

Volunteer, Bryan, thoroughly weeding up to the weed front at Waterfall Gully Reserve. Photo: A. Crompton

General view of regenerating vegetation after two years of weed removal. Photo: A. Crompton

The work started as a standard revegetation project in summer 2005-06 when the first part of the reserve (about 0.3 ha) was cleared. We slashed and sprayed the weeds and planted *Eucalyptus camaldulensis* and *Acacia melanoxylon* on land subject to flooding, and *Acacia pycnantha* and *Allocasuarina verticillata* and other appropriate species on the higher ground. At first only trees are planted because they do not interfere with weed control on the ground.

Initially a contractor was engaged to do a complete follow-up weed spray but the quantity of germination of indigenous plants on the site ruled this out. You can always assume that there is scope for some natural regeneration on any site, but just how much was possible on this site gradually became obvious.

Every week during winter and spring 2007 it seemed as though a new indigenous species was identified naturally regenerating on the site. To date, 66 indigenous species have been identified. Some of these are only represented by a few individuals and, while they are interesting occurrences, they may not persist as the ground becomes covered with more vigorous species. But many species are in sufficient numbers to contribute to the eventual vegetation community as it develops. Many of the species typical of local native riparian vegetation have regenerated naturally, including *Acacia provincialis, Eucalyptus camaldulensis, Gahnia sieberiana, Goodenia ovata* and various species of *Carex, Cyperus, Juncus* and *Isolepis.* Some riparian species that occur not far upstream have not regenerated naturally at the site. These include *Rubus parvifolius* and *Leptospermum lanigerum*. The massive germination of the indigenous colonising species *Sigesbeckia orientalis* at the site appears to be seriously competing with other regenerating flora. At present we are suppressing it with a whipper-snipper, and trial plots are planned to determine the best management approach.

At the rate of about one weed every week, the volunteers have gradually learned collectively to recognise most of the weed species on the site and to carefully remove them.

So far 75 introduced species have been identified including species such as *Cyperus involucratus* and *Arundo donax* that look like indigenous species and require care to determine correctly. Volunteers starting from a very low knowledge base are now doing work at the site that few contractors are able to do.

So, even though this was a very degraded site with almost no native vegetation evident, it has turned out to have a remarkable seed bank of indigenous flora. Its location on a flood plain, and subject to sediment deposition from native vegetation upstream, makes the regeneration of a large number of species quite understandable, but it is only the thorough and careful removal of weeds that has realised the regeneration potential of the site. It will be interesting to see how much weed work will be required after the next flood and whether the indigenous flora, when established, will have a degree of resilience.

Conclusion – Quality Vegetation from Very Degraded Sites

Our approach for developing quality vegetation on very degraded sites is to:

- choose an area that matches the work force available;
- protect visible indigenous plants present and clear the rest;
- follow-up weed control frequently and thoroughly;
- identify all plants as soon as possible after germination;
- remove plants when they are identified as weeds;
- minimise trampling of vegetation;
- minimise disturbance of the soil when removing weeds;
- plant or sow appropriate species when native flora does not regenerate; and
- adapt the management to the requirements of the site.

To do this requires:

- field workers who want to learn;
- local plant knowledge;
- site assessment experience;
- persistence and attention to detail;
- resources for a process not a project; and
- willingness to adapt work rate and method to the requirements of the site.

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Flowering and seed production in the endangered Spiny Daisy, *Acanthocladium dockeri*

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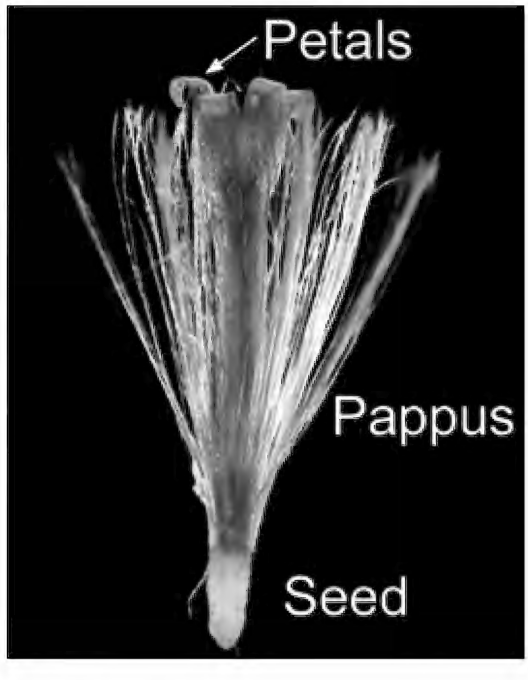
Spiny Daisy (*Acanthocladium dockeri*) is a critically endangered shrub occurring in five small roadside populations in the arable Mid-North of South Australia (Jusaitis 2007). The populations are referred to as Thornlea, Yangya, Hart, Rusty Cab and Telowie, in the order of their discovery. Each natural population consists of a single, distinct, genetic clone, proliferating vegetatively by root suckering (Jusaitis and Adams 2005a, b; Jusaitis 2007). Because clonality may affect gene flow and seed set, particularly in self-incompatible species (Sydes and Peakall 1998), it was important to determine if low pollen viability and seed set are contributing to the lack of seedling recruitment observed in the field.

Flowering

Spiny Daisy produces composite flower heads (capitula) consisting of numerous flowers (florets) (average of 19±0.6) clustered in each head (Fig. 1). Flower heads are borne singly on short or no stalks and occur apically or laterally on new branchlets. Flower buds approaching maturity often display a characteristic bronze colouration due to the surrounding bracts. Open capitula lack conspicuous ray (strap-like) petals, but appear yellow at full bloom due to the colour of the other petals (Fig. 2), anthers and styles.

The five clones have varied in flowering intensity between populations. Plants at Hart and Thornlea were prolific flowerers, and some buds or flowers could be found on these plants throughout the year. However, only scant flowering was observed on plants at Rusty Cab and Yangya, perhaps due in part to periodic grazing of plants by introduced white snails (Jusaitis and Adams 2005b). However these inter-clonal differences were not entirely due to environmental factors, as similar trends in flowering intensity were observed in plants grown under uniform conditions in the nursery.

Peak flowering usually occurred between February and June. Honeybees, flies and wasps were seen working flowers at Hart on warm, sunny days. Flowering was followed by a period of vegetative growth from late autumn into winter (May-July). Growth flushes and flowers were also observed at other times of the year, possibly in response to seasonal conditions. Mature seed heads were most abundant between March and May.



Left: Figure 1. Spiny Daisy flower heads (capitula) on nursery-grown plants.
Right: Figure 2. Individual flower (floret) from a Spiny Daisy capitulum. Photos: Manfred Jusaitis

Pollen

Spiny Daisy florets produce copious pollen. Pollen grains are spherical, have three pores (triporate) and short spines, and a diameter of 27.3±0.5 µm (1 µm = 0.001 mm). Germinability of pollen was tested on pollen germination medium (Brewbaker and Kwack 1963) and found to be extremely low. No germinants were observed with Rusty Cab or Telowie pollen, and only 0.33%, 0.19% and 0.12% of Hart, Yangya and Thornlea pollen (respectively) germinated, although differences between populations were not significant. Pollen tube growth was considerably slower than that observed for other species: after 24 hours of incubation, tubes were no more than twice the diameter of the pollen grain in length, and some appeared deformed.

The sexual variation found in Spiny Daisy appears to be genetically rather than environmentally or ecologically based, as pollen collected from greenhouse-grown plants had similar levels of viability and germination to that collected in the field.

Seed Production

Seed production was studied between 2000 and 2008 by collecting, at intervals, mature capitula from each population and counting the number of full seeds on each capitulum. Seed set was very low (0-0.99 seeds per capitulum), with an overall average of 0.1 (Fig. 3). Rusty Cab and Thornlea had the lowest seed set, while Yangya and Hart yielded significantly more seed. Telowie produced the record seed set of 0.99 seeds per capitulum in November 2007, but no seeds were found in more recent collections from that site during summer and autumn.

The proportion of florets to set seed fluctuated with season and location, ranging from none to 2.7% (mean = 0.6±0.1%), but did not differ significantly among populations. The proportion of capitula with at least one full seed varied between zero and 43%, with an average across all populations of 7.3±2.1%. Again, this attribute didn't differ significantly among populations. Thus, all populations of Spiny Daisy appeared to have extremely low levels of sexual reproduction that was apparently related to low pollen germinability.

Seeds of Spiny Daisy are oblong in shape (Fig. 4) and have no endosperm. A minutely papillose outer seed coat encases a linear embryo with well developed cotyledons and a broad stalk. Seed length has varied significantly among populations, averaging 1.93 mm at Hart, 2.13 mm at Thornlea, 2.25 mm at Yangya, 2.3 mm at Rusty Cab and 2.35 mm at Telowie, with an overall mean of 2.19 mm. Seeds germinated readily and did not appear to have any dormancy-breaking requirements.

Regenerating seedlings have not been observed in the field despite the potential for long-distance dispersal of seed. Secondary dispersal by wind or rain is prevented in Spiny Daisy by the formation of a mucilaginous coating around hydrated seeds, which enables them to adhere strongly to soil particles.

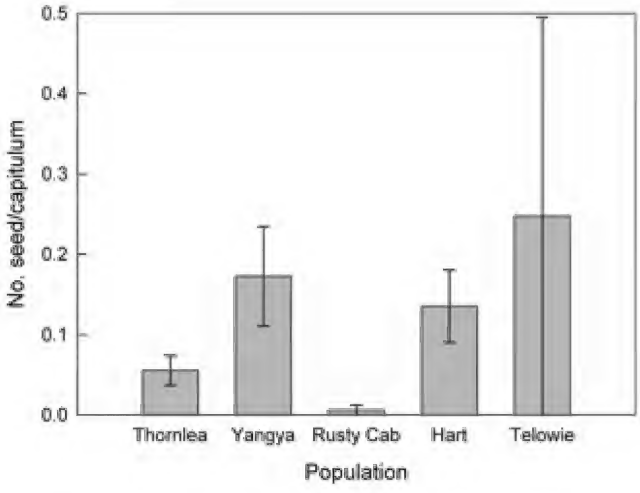


Figure 3. Mean number of seeds per capitulum in Spiny Daisy flower heads taken from each population between 2000-2008. Vertical bars represent Standard Error of means.

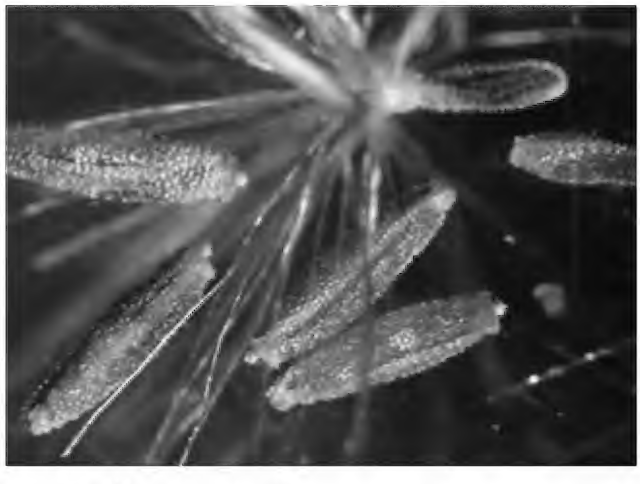


Figure 4. Mature seed of Spiny Daisy collected from the Hart population. Photo: Manfred Jusaitis

Summary

Seed set in flowers of Spiny Daisy is very low, probably due to low pollen germinability. On the basis of this, and earlier results, Spiny Daisy is considered at high risk of extinction because of its low genetic diversity, poor seed production, lack of seedling recruitment and population growth by clonal reproduction alone.

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A toolkit for conservation on private land: winning hearts and minds

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Introduction

Large areas of the Western Australian Wheatbelt are clearly showing signs of environmental stress, largely resulting from over-clearing. Impacts include salinity, rising watertables and the effects of fragmentation and isolation. Some shires have less than 3% native vegetation remaining, much of which is in poor condition and subject to ongoing threats such as uncontrolled grazing by domestic livestock and feral species. This causes the native vegetation to further degrade through altered nutrient balances, competition and lack of natural regeneration. Despite all this, a large amount of irreplaceable biodiversity still persists in these patches of remnant vegetation, the majority of which occur on private or shire-managed land. Therefore, in order to ensure the long-term survival of this biodiversity, it is vital to win the hearts and minds of private and shire land managers to the cause of conservation, and to encourage and support their efforts in bushland management.

With this goal in mind, WWF-Australia has been running a targeted extension project, working with shires and private landholders in the WA Wheatbelt, for almost ten years. Originally called 'Woodland Watch' the current projects in the Avon and Northern Agricultural Natural Resources Management (NRM) regions ('Healthy Ecosystems' and 'Woodland Watch', respectively) have generally concentrated on eucalypt woodlands under-represented in the conservation estate and the wealth of biodiversity that resides within them.

The Wheatbelt Woodlands Projects

Since 1998 Woodland Watch / Healthy Ecosystems, has achieved many significant results in the Wheatbelt, with large areas of bushland now protected through fencing, legal protection and/or improved management. Over 1300 ha of native vegetation has been permanently protected by conservation covenants so far (with another approximately 2000 ha under negotiation) and 66 voluntary management agreements have been signed protecting over 7000 ha of native bushland. Funding has also been sourced for hundreds of kilometres of fencing. However, the greatest conservation outcomes of the project may in fact be long-term change in landholder and general community attitudes to bushland and its management. In order to achieve these outcomes, the WWF team has utilised a 'toolkit' of techniques which make up the 'Woodland Watch' model of targeted extension.

The Toolkit

The project uses extension, survey and information sharing to engage land managers in conservation and management of Wheatbelt bushland. Strong partnerships with science and conservation communities, and maintaining good networks in the community are important contributors to the toolkit. However three aspects of engagement have been particularly successful: flora surveys, enthusiastic and informed extension officers, and financial incentives.

Flora Surveys

Since the inception of its Wheatbelt woodland projects, WWF has been working with the Department of Environment and Conservation's WA Herbarium to undertake flora surveys on private and shire-managed land throughout the Wheatbelt. These flora surveys, while contributing substantially to scientific knowledge of the Wheatbelt flora, are also a very important tool for engaging landholders in the conservation of their bushland. Flora surveys provide context to landholders on the specific importance of their individual patch of bush to biodiversity as a whole, as well as providing an insight to the astounding biodiversity contained within even the smallest patch of remnant vegetation.

The flora surveys and accompanying site reports also provide land managers with an increased knowledge of the value of their bush and actions they can take to improve or maintain its condition. As well as discussing vegetation condition, extension officers also provide information on the habitat value of the bushland, and record any fauna (or signs of fauna) observed during the survey.

Extension Officers

The role of enthusiastic and informed extension officers in the success of the project cannot be over-estimated. The ability to discuss all aspects of bushland with landholders, and to be excited about all of it, is an essential attribute in an extension officer. The project uses one-on-one interaction with managers of bushland to achieve its goal, providing landholders with an increased and personalised understanding of the biodiversity of their bushland and its context in, and contribution to, landscape-wide conservation of priority ecosystems.

Building a mutual relationship of trust and respect is the number one priority of the extension officers in the project. Once established, and maintained, trust and respect from

Landholder Murray Clement and son Rex talking to Jess Forsyth, the local natural resource management officer, during a WWF-Australia site visit following a flora survey. Photo: H. Mills

landholders spreads to the wider community, resulting in greater conservation outcomes. There are numerous examples of landholders contacting WWF extension officers to talk about their 'bush' after talking to a neighbour or friend who has already had contact with a biodiversity conservation extension officer.

WWF commissioned a social impact assessment of the Woodland Watch project in 2005 (Rowley 2005). After interviewing a number of landholders, the importance of the extension officers was confirmed. Many landholders are aware of declining bushland and are looking for the resources and information to help them deal with the situation. One landholder said "My long term view is that our bush remnants are declining. I valued the bush as a kid for playing in and it just sort of dawns on you as you get older that this bush isn't permanent – when you are young you think it will last forever".

Financial incentives

While extension officers are the most important part of the work of WWF in the Wheatbelt, and they have been instrumental in increasing the value landholders place on their native bushland, being able to leverage funding for high-investment on-ground works, particularly fencing, has also been an important factor in the success of the project. Also significant in the project outcomes, where possible, has been the application of one-off covenanting incentive payments. While payments are not sufficient to cover the long-term costs of rates and maintenance, where good-will and interest has already been established, they often assist in the transition from thinking it would be nice to permanently protect the bush, to actually doing so.

The work of WWF in the Wheatbelt is currently being carried out with cooperation and funding from the Northern Agricultural Catchments Council and the Avon Catchment Council.

Summary

WWF, in its decade of working with private landholders and shires in the WA Wheatbelt, has achieved some outstanding results in on-ground conservation of native vegetation. In order to do this, the WWF team has utilised a 'toolkit' of techniques that together make up the 'Woodland Watch' model of targeted extension. This model is currently being applied to NRM delivery projects in the Northern Agricultural and Avon regions. One-on-one extension, survey and information sharing are used to engage land managers in conservation and management of Wheatbelt bushland. Backed up with incentives, flora surveys, and enthusiastic extension officers, this model continues to work in the Wheatbelt. Continuous improvement is also an aim of the project, and part of WWF's international project management standards. Therefore the WWF Wheatbelt team is always on the lookout for extra tools that can be added to the kit for even more effective bushland conservation in the future.

Acknowledgements

This project is delivered with investment from the Western Australian and Australian Governments through the Natural Heritage Trust and the National Action Plan for Salinity and Water Quality programs, through the Avon and Northern Agricultural Catchments Councils.

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Eucalypt woodland management and restoration in Western Australia: what have we learnt?

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South-western Australia is recognised internationally for its mega-diverse endemic flora that persists in a landscape dominated by wheat and sheep. The wheatbelt, as it is locally known, sits between the higher rainfall forests of the extreme south-west and the arid ecosystems further inland. Prior to clearing for agriculture, eucalypt woodlands clothed the slopes and the valley floors of the gently undulating landscape. The integrity of the remaining eucalypt woodlands is threatened by the same factors that affect native ecosystems within agricultural landscapes elsewhere (e.g. livestock grazing, weed invasion), although their apparent inability to recover once these threats are removed is exceptional.

Prospects for Recovery

There are several reasons why we would expect the recovery of eucalypt woodlands to be slow or non-existent, and most of these relate to the inherent characteristics of the ancient landscape and its flora (Fig. 1). First, ecosystems on ancient landscapes are generally less resilient to disturbances induced by agriculture than systems on landscapes of more recent origin, because such disturbances irreversibly reduce their ability to recycle nutrients and retain water. Second, the flora is dominated by species with low potential growth rates which reduces their ability to rapidly colonise disturbed ground. Colonisation can be limited further by competition with exotic species that can respond rapidly to soil disturbance, particularly where it is accompanied by an increase in resource availability. Third, the capacity for recovery is limited by the availability of local fresh seed and vegetative material because limited seed dispersal is common and most species do not maintain a persistent soil seed bank (Standish *et al*. 2007).

Figure 1. The granitic rocks that characterise the landscape in this region are between 2500 and 2900 million years old. They are part of the inert and rigid Yilgarn Craton which has weathered over geological time to produce a gently undulating landscape. Photo: Peter Mioduszewski

Another consequence of the ancient landscape is that plant nutrient-acquisition strategies, such as cluster roots and mycorrhizal associations, feature more prominently here than elsewhere in the world (Lambers *et al*. 2008). This is relevant to the recovery of eucalypt woodlands for two reasons. One is that mycorrhiza might be necessary to enable the recovery of the plant species that form symbiotic associations with them. The second is that the nutrient-acquisition strategies can render some species, and particularly species in the family Proteaceae, susceptible to phosphorus toxicity. Therefore, the recovery of these species might be limited along the boundaries of woodland remnants affected by P-fertiliser drift or abandoned farmlands affected by P-fertiliser residues.

Recovering Degraded and Cleared Woodlands

The prospects for unassisted recovery of eucalypt woodlands are limited. Therefore, without active intervention, degraded woodlands will continue to decline (Saunders *et al*. 2003) and abandoned farmlands will potentially remain 'stuck' in a weedy state (Standish *et al*. 2007; Fig. 2). Large-scale restoration is a daunting task, yet this is what is needed to increase the representation of eucalypt woodlands – comprising both rare and common species – in the landscape. There are some visionary examples of large-scale restoration in the region (http://www.gondwanalink.org/; http://www.naturebase.net/content/view/447/1390/). The challenge for these and other restoration practitioners is to:

- optimise efforts across the landscape by prioritising restoration sites according to the effort needed to restore them;
- recognise the signs of degradation that act as barriers to recovery and apply the treatments that are appropriate to overcome each one; and
- approach farmers to sell their land or to assist with the restoration efforts.

Figure 2. Exotic annual grasses can persist on wheatbelt old-fields 30 to 40 years after abandonment. Photo: Rachel Standish

How Can Research Help?

We have recently revised a state-and-transition model as a guide for the management and restoration of eucalypt woodlands (Standish *et al*. 2008; Figure 3). The model is based on research by Colin Yates and Richard Hobbs on the barriers affecting the recovery of woodlands degraded by grazing livestock, work by Viki Cramer and others on the decline of woodlands resulting from secondary salinity and our work (cited earlier) on the recovery of old-fields after abandonment. It recognises five vegetation states and predicts the existence of three barriers, which can be overcome by different restoration treatments (Fig. 3). The vegetation states are deliberately generic so as to focus on the thresholds between them. However, the model could be expanded and filled with specific examples so as to make it more relevant to those involved.

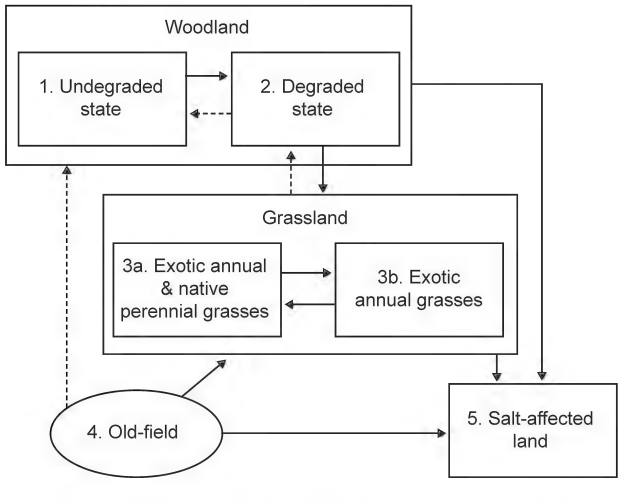

Figure 3. A state-and-transition model for eucalypt woodlands in south-western Australia. Transitions towards more degraded states are indicated by the solid lines. Favourable transitions, indicated by the dashed lines, are usually prevented by thresholds (not drawn). A favourable transition from salt-affected land is always prevented by the fourth threshold (these are not drawn). From New Models for Ecosystem Dynamics *by Richard J. Hobbs and Katharine N. Suding, forthcoming from Island Press in Fall 2008.*

The construction of a state-and-transition model is a useful first step in the process of developing management and restoration strategies for eucalypt woodlands. The model can be used as a framework for addressing the challenges outlined above, and has also highlighted the gaps in our knowledge. Many of these relate to the need to improve the techniques currently available for restoration. For example:

- how can we improve establishment from broadcast seeds?;
- does the re-introduction of soil cryptogams accelerate woodland recovery?; and
- can we improve the establishment of understorey species that are sometimes missing from restoration plantings?

There is also a need, in some instances, to evaluate the utility of current practices. For example, despite the widespread commitment to fencing woodland remnants in the region, it is unclear whether the exclusion of grazing livestock is enough to ensure recovery. Similarly, the common assumption among the carbon traders is that single-species plantings hold more carbon than multi-species plantings. This assumption has not been tested, despite the potentially significant contribution to biodiversity conservation if the current practice could be altered to include even a sub-set of local woodland species.

Conclusions

Eucalypt woodland ecosystems have a low resilience to grazing and cultivation, and generally do not bounce back after these disturbances are removed. Past clearing of vast areas of native vegetation for agriculture has resulted in a highly fragmented landscape. This, together with declining rainfall, invasion of exotic species and the interactive effects of these drivers, continues to have a dramatic effect on the woodlands in this region. Their restoration is challenging and only likely to become more so into the future. We still have much to learn about the ability of these unique ecosystems to cope with the ongoing effects of human-induced changes. Such knowledge is essential for both management and restoration – to maintain the integrity of existing woodland remnants and to restore systems that are resilient to these changes.

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'Kurrajong Gardens', a grassy box woodland rural residence near Canberra

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Background

My property 'Kurrajong Gardens' is included in the New South Wales Grassy Box Woodland Conservation Management Network. I purchased the land, slightly more than 16 ha (40 acres) in 1982. It was part of a rural subdivision in the Burra Valley, about 45 km southeast of Canberra. There had been one previous owner of the block, for the first 18 months after the subdivision, and in that time he had poisoned a number of large briars and fenced a significant part of the area.

The name 'Kurrajong Gardens' reflects the fact that the Kurrajong tree (*Brachychiton populneus*) is a local plant (one is growing on a steep bushy slope on the neighbour's place), it is a 'bush tucker' plant, has low water requirements and can be a fire retardant. A number of Kurrajongs have been planted on the block, mainly in rocky situations, which they often prefer. They function as an integrating theme for the whole block.

Remnant grassy woodland at 'Kurrajong Gardens' (A) has made the property eligible for inclusion in the Conservation Management Network (B). Photos: Ian Anderson

The Land

The block is at an elevation of more than 800 metres at its highest point. It receives heavy frosts at times and occasional dustings of snow in winter. It includes a relatively flat area of several hectares, rising through increasingly steep slopes to a small plateau which has views of the nearby Tinderry Range. The whole area probably comes within the Atherton to Alps corridor, proposed as a conservation refuge against the likely impacts of climate change.

The soil on the block is of granitic origin and there are lots of granite boulders and outcrops, especially on the steeper parts. The previous owner had the soil tested and said it was quite high in nutrients, although like many Australian soils relatively low in phosphorus. The soil drains well, an advantage for growing many native plants, though not for holding water in dams.

The land was, I have been told, almost totally burnt a few years before I became the owner, when burning off on a nearby property spread further than was planned. This may explain why I did not see any Drooping Sheoak (*Allocasuarina verticillata*) on the steeper rocky north-facing slope when first inspecting the block. This species has now grown back well and covers several hectares, in combination with a number of different eucalypt species and understorey plants. One of the most exhilarating sounds resulting from this has been the call of the threatened glossy black cockatoos as they fly across or into the allocasuarinas, a major feeding source for them. In recent years there have been breeding records for these birds in the neighbourhood, including the nearby Urila Valley.

Land Use

The land had for a long time been part of a vast grazing property established in the 1800s. I had no intention of grazing it, but initially did have ideas of growing some tree crops like fruit or olives on a small part of the flatter land. However, the hordes of white cockatoos roosting in the nearby trees most nights suggested that any crop might not last long. Keeping bees seemed a good idea in the early years and I did have a hive or two for a while.

The woodland garden is a just a step away from the house (C) and supports local wildlife (D). Photos: Ian Anderson

The valley was popular with commercial beekeepers, probably because of the large number of Yellow Box (*Eucalyptus melliodora*) trees still standing. However, feral bees occupying nest hollows for birds became an increasing concern.

Grassy Woodland as Garden

About the time I purchased the block I joined the Society for Growing Australian Plants (ACT Region). After the severe drought in 1982-83 broke and was followed by an extremely wet year, I became increasingly captivated by the attractiveness of the ground flora that flourished on much of the block, in combination with the woodland trees still growing on the partially cleared landscape. Woodland suddenly seemed just as appealing as rainforest. It was easy to walk in and see through when looking for wildlife and the vegetation ranged from large trees to shrubs, grasses, ferns and orchids. It lent itself well to different kinds of appeal to the eye, as the light filtering through it varied. What better use of the land could there be than to preserve and perhaps enrich (given climate change predictions) the remnant woodland which remained after more than 100 years of grazing. The whole block could be a woodland garden.

Fortunately for its woodland qualities the block was not pasture improved except around the relatively recently constructed dam. Here introduced Phalaris grass was planted. The Phalaris has become a minor weed, obvious in wet years but struggling in dry times. It is eaten a little by resident herbivores such as kangaroos and wombats, but they mostly prefer native species.

Natural Regeneration and Plantings

Since I purchased the block there has been a lot of natural regeneration of trees, shrubs and herbs. Tree species include *Eucalyptus bridgesiana, E. melliodora, E. pauciflora and E. rubida*. Herbs that have regenerated include the native grasses *Themeda triandra, Poa sp. and Microlaena stipoides,* orchids such as *Dipodium, Thelymitra and Diuris* and members of the pea family including *Indigofera australis, Hardenbergia violacea, Cullen microcephalum, Desmodium* sp., *Glycine clandestina, Hovea linearis, Lotus australis* and *Swainsona sericea.*

Species I have planted for conservation enrichment or climate change purposes, which have survived to date under natural conditions once established, include the grassy woodland plants *Banksia marginata, Eucalyptus albens, E. blakelyi, E. microcarpa, E. polyanthemos* and *Rutidosis leptorrynchoides* as well as *Acacia subulata, A. triptera, Angophora bakeri, Eucalyptus caesia* (silver princess), *Callistemon brachyandrus, Grevillea beadleana, Hakea petiolaris, Melaleuca elliptica* and *Wollemia nobilis.*

No Longer an Intruder

A most rewarding experience in a woodland, especially when your garden is one, is to stroll about in it and enjoy its beauty, interactions and diversity. It is a bonus when the kangaroos do not rush away from you in fear and the birds queue up to use the birdbath you have recently filled. You feel that, to some extent at least, you are a part of the woodland rather than an intruder, and that your woodland garden is helping to protect this threatened ecosystem.

Kangaroo Grass: a keystone species for restoring weed-invaded temperate grassy woodlands

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Conventional approaches to controlling environmental weeds often target the invading species directly. For example, weeds can be removed manually or killed by herbicides. However, these 'top-down' approaches are often ineffective, because the weed can easily re-invade or be replaced by other weed species. A solution to this problem is to combine 'top-down' weed control with an ecological approach that targets the 'bottom-up' restoration of the native ecological community (Sheley and Krueger-Mangold 2003).

The key to 'bottom-up' restoration is to recreate an ecosystem that maintains an environment that is unfavourable to weeds, and so is 'resistant' to weed invasion. The key to such ecological resistance is often related to interactions between native species and their environment. For example, a native species may pre-empt resources such as light, nutrients or water, so that weeds are unable to grow, or might secrete allelopathic chemicals that inhibit weeds. Some weeds can invade natural, undisturbed ecological communities, and this approach will not be successful for controlling such species. Commonly though, weeds invade most vigorously when external disturbances destroy the ecological resistance of the native community.

Restoring Resistance to Weed Invasion

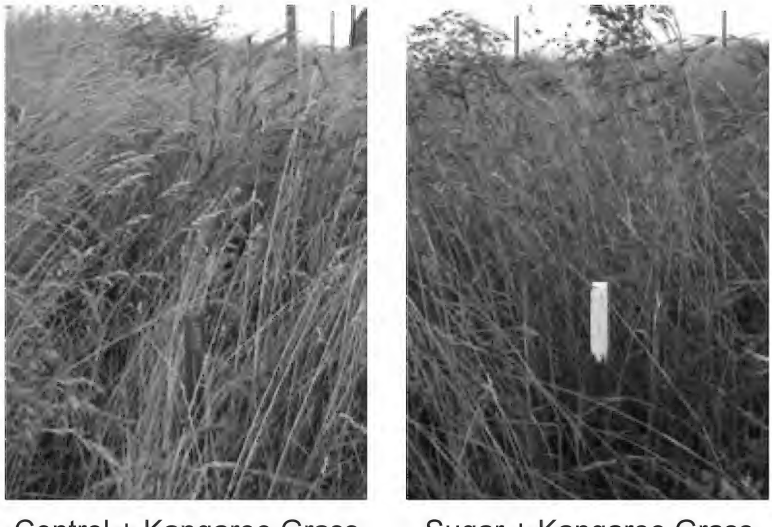
The 'bottom-up' approach is relevant to restoration of Kangaroo Grass (*Themeda triandra*) dominated grasslands and grassy woodlands across southern Australia. As a result of livestock grazing, fertilisation and other disturbances, Kangaroo Grass has been lost from many remnants of these ecosystems, and they have instead become dominated by annual weed species and other natives. The weeds outcompete native forbs and change habitat conditions for native fauna, leading to reduced woodland diversity over broad scales.

How then do we restore natural resistance to invasion by exotic annuals in these grassy ecosystems? What are the ecological processes we need to restore, and what native species drive these processes?

In an earlier issue of *Australasian Plant Conservation* (Prober *et al.* 2004) we described some novel approaches for restoring weed-invaded native understoreys in temperate Kangaroo Grass ecosystems. We showed that areas heavily invaded by exotic annuals had high soil nitrate levels, whereas areas with few exotics had very low soil nitrate levels. We hypothesized that soil nitrate was the key underlying driver of natural resistance to weed invasion in these ecosystems, and that if soil nitrate could be reduced, weeds would grow less and establishment of native plants would be enhanced.

We tested these hypotheses in field trials near Young, NSW, and found that in weedy areas with high soil nitrate, Kangaroo Grass was unable to re-establish even when we added lots of its seed (Fig. 1). However, when we actively intervened to suppress weeds, Kangaroo Grass was able to re-establish successfully.

We effectively reduced weeds using two very different techniques: (1) by reducing soil nitrate levels using carbon (sugar) additions, and (2) by reducing weed seed banks by



Control + Kangaroo Grass Sugar + Kangaroo Grass

Figure 1. In this weedy site Kangaroo Grass was not able to establish when we added Kangaroo Grass seed (Control + Kangaroo Grass). However when we suppressed the soil nitrate supply to weeds by adding carbon (sugar), Kangaroo Grass established very effectively (Sugar + Kangaroo Grass). Few weeds were then able to persist in the re-established Kangaroo Grass sward, even when we stopped artificially suppressing nitrate using sugar. Photos: S. Prober

burning the standing weed crop before it set seed. Other techniques such as spraying might be similarly effective, so long as Kangaroo Grass seed is added. The first method conclusively demonstrated the importance of soil nitrate: by reducing it, weed growth was greatly reduced and native plant establishment was enhanced.

But how sustainable is this approach? The critical next step was to ensure that weeds did not re-invade after we stopped actively controlling them. For example, sugar addition only provides temporary weed control, because soil nitrate increases again after about three months. Similarly, annual weed seeds can move in from surrounding areas even if their seed banks are controlled on-site.

Three years after we successfully established Kangaroo Grass by adding sugar or burning, we found some exciting results (Prober and Lunt 2008). In many places, the Kangaroo Grass seedlings had grown to form a dense sward (Fig. 1). When we measured soil nitrate levels beneath these swards, we discovered that they had become extremely low, even on burnt plots where we had never added sugar (Fig. 2). Indeed, soil nitrate levels were similar to those we have measured in weed-free, undisturbed reference sites.

In these places, few weeds were able to grow with the Kangaroo Grass. In more intact remnants, we've found that even when Kangaroo Grass swards are burnt or mown, allowing plenty of light through the recovering sward, nitrogen-loving weeds remain inhibited. It appears then that the ability of Kangaroo Grass plants to lock up soil nitrate is an important mechanism for inhibiting weeds. This has led us to conclude that Kangaroo Grass is a keystone species in these ecosystems, providing long term resistance to invasion by nitrogen-loving exotic annuals through its ability to control soil nitrate.

Other Native Species

With Ian Cole from the NSW Department of Environment and Climate Change, we are undertaking further studies to test whether other native grasses are as effective as Kangaroo Grass for providing this ecological resistance to weed invasion in temperate grassy ecosystems. Preliminary indications are that other species are not as effective, suggesting that Kangaroo Grass itself is one of our most important tools for restoring these ecosystems.

Another question is whether desirable native species are inhibited by Kangaroo Grass due to its effects on soil nitrate. A study by one of our honours students, Lisa Smallbone, provided illuminating results. Lisa's pot trials indicated that increased levels of soil nitrate can increase the growth rate of native forbs, but that nitrogen-loving exotic annuals are far more inhibited by low soil nitrate levels than are many native forbs. This suggests that while low soil nitrate levels might reduce the growth rate of native forbs, the forbs may still be better off because they don't need to compete with weeds (Smallbone *et al.* 2008). When Lisa tested this in the field experiment, she found that native forbs established significantly better on plots where we reduced soil nitrate levels to control weeds (Smallbone *et al.* 2007).

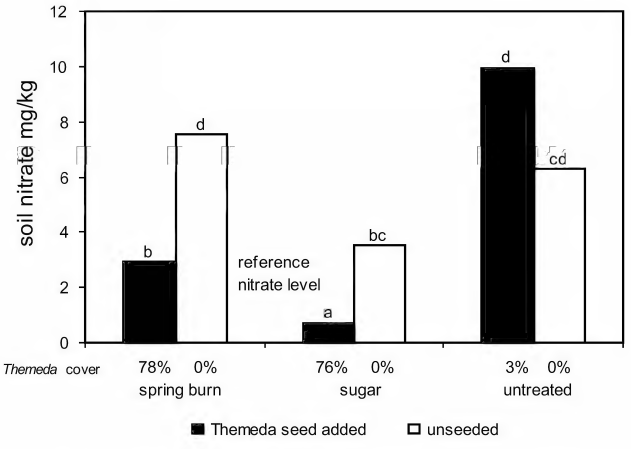


Figure 2. These data show how soil nitrate was suppressed on plots with established Kangaroo Grass (Themeda) swards (with >75% cover as indicated), compared with higher soil nitrate on plots where Kangaroo Grass didn't establish successfully (0-3% cover). Soil nitrate on unseeded sugar plots remained somewhat suppressed due to the residual influence of sugar, but was still higher than on the seeded plots. The reference nitrate level indicates levels we typically measure in weed-free reference sites. Different letters indicate that treatments are significantly different at P<0.005. Modified from Prober and Lunt (2008).

Conclusions

Our simple message here is that to restore weed-invaded native understoreys in temperate Kangaroo Grass ecosystems, we need first to focus on restoring swards of Kangaroo Grass, using any effective short-term intervention (such as those we've mentioned). Once we achieve a healthy sward, this species will then do the ongoing weed control for us, by locking up soil nitrate and creating an environment unfavourable to weeds.

This provides an effective example of a 'bottom-up' approach to weed control. By re-establishing Kangaroo Grass, we remove an underlying driver of weed invasion and create an ecosystem that is resistant to annual weeds in the longer term.

Acknowledgements

This work was funded by the NSW government through its Environmental Trust. We thank the Johnson family for generously assisting with these studies on their property 'Windermere' near Young, NSW.

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The conservation value and reservation status of the Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands of south-eastern NSW

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Introduction

The Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands are a broad association of several closely related woodland communities, restricted to the NSW Southern and Central Tablelands. These communities share many common characteristics, including component species, structure, and geographic distribution. Because of extensive clearing and fragmentation, poor reservation status, and ongoing threats to the long-term persistence of these communities in nature, a nomination to the NSW Scientific Committee has recently been made to list the Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands as an Endangered Ecological Community in NSW.

Structure and Composition

The Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands have a woodland to open-woodland structure (Costin 1954). Tree crown cover is variable and tree height is between 5 and 25 m (Hunter 2002; NPWS 2003; Gellie 2005; Tozer *et al*. undated). Shrubs greater than 1 m tall are generally sparse, but may be locally common depending on site characteristics and management history. Sub-shrubs (<1 m tall) may be a common component of this community. The ground layer is naturally species-rich, dominated by grasses and other herbaceous species (NPWS 2003; Tozer *et al*. undated).

Snow Gum in a road reserve near Oberon. Photo: James Crooks

The species composition of the community is influenced by the size of the site, recent rainfall or drought conditions and by its disturbance history (including grazing, land clearing and fire). Characteristic species of the overstorey are Snow Gum (*Eucalyptus pauciflora*), Candlebark (*E. rubida*), Black Sallee (*E. stellulata*) and Ribbon Gum (*E. viminalis*). Silver Wattle (*Acacia dealbata*) and Urn-heath (*Melichrus urceolatus*) often populate the shrub layer. The diverse ground layer includes the grasses Kangaroo Grass (*Themeda triandra*), *Poa* spp., *Austrostipa* spp., and *Austrodanthonia* spp., and the herbs *Chrysocephalum apiculatum* and *Hydrocotyle laxiflora*.

Distribution and Habitat

The Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands occur at an altitude of 600-1397 m, where annual average precipitation ranges between 550-1080 mm (Hunter 2002; Keith 2004; Tozer *et al*. undated). The community occurs on soils derived from a variety of substrates, including granite, basalt, sediments, colluvium and alluvium (Costin 1954; Keith 2004; Tozer *et al*. undated).

This community was once widespread across large areas of south-eastern NSW. Approximately 95% of its pre-European extent has been cleared (Keith 2004; Gellie 2005; Tozer *et al*. undated), and much of the remaining area is comprised of small, fragmented patches surrounded by native and exotic pasture.

Threatening Processes

Many woodland ecosystems of south-eastern Australia are now reduced in size, are in poor condition and highly fragmented (Yates and Hobbs 1997). The Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands of south-eastern NSW are no exception. Threats to the community include clearing, grazing, exotic plant introduction, weed invasion, firewood collection (Keith 2004; and Tozer *et al*. undated), tree dieback, fragmentation effects and changed fire regimes.

Reservation Status

Less than 5% of the community's pre-1750 area is found in conservation reserves (derived from Gellie 2005; Tozer *et al.* undated). Reserved examples are generally small in area, isolated from other remnants of the community, and are often at the boundary of the reserve where edge effects are high.

Prasophyllum wilkinsonorum *(left) and Mauve Burr-daisy (*Calotis glandulosa*) (top), rare and vulnerable species (respectively) occurring within the Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands. Photos: Rainer Rehwinkel*

Conservation Values

Many threatened species are known to occur in the community, including the Pink-tailed Worm Lizard (*Aprasia parapulchella*), Mauve Burr-daisy (*Calotis glandulosa*), Brown Tree-creeper (*Climacteris picumnus victoriae*), Tarengo Leek Orchid (*Prasophyllum petilum*), Button Wrinklewort (*Rutidosis leptorrhynchoides*), Diamond Firetail (*Stagonopleura guttata*), and Austral Toadflax (*Thesium australe*).

Other rare or declining species known to occur within the community include the White-winged Triller (*Lalage suerii*), Restless Flycatcher (*Myiagra inquieta*), Scarlet Robin (*Petroica multicolour*), Key's Matchstick (*Keyacris scurra*), Raspy Wood-cricket (*Cooraboorama canberrae*), and the plants *Microseris lanceolata, Podolepis jaceoides, Diuris lanceolata, Prasophyllum wilkinsonorum* and *Lotus australis*. Remnants that contain any threatened, rare or declining species are considered to be of high conservation value.

Old-growth elements, the shrub layer and an intact ground layer are greatly affected by past and present land use practices. The ground layer in particular has been highly modified by European land management practices (Keith 2004). Examples with high species richness are considered to be of high conservation value. These are generally found only in travelling stock reserves, roadside remnants, cemeteries (Keith 2004), and occasionally private property.

Clearing has resulted in widespread fragmentation of the community, and large remnants are now rare. Vegetation modelling demonstrates the degree of fragmentation since European settlement (e.g. Gellie 2005; Tozer *et al.* undated), with the modelled extent of the community reduced to many very small patches. Remnants greater than 2 ha in size are considered to be of high conservation value.

Conclusion

The naturally species-rich Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodlands of south-eastern NSW were once widespread throughout the NSW Southern and Central Tablelands. Extensive clearing for agricultural development has fragmented this community, and a range of European land management practices continue to threaten remaining remnants. In recognition of past and present impacts, a nomination to list the community as an Endangered Ecological Community in NSW has recently been made to help protect it in the future.

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Translocation of a threatened orchid species: a case study from central Victoria

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It is generally acknowledged that threatened species are best conserved *in situ*, but what if the site where they currently exist is going to be completely and irrevocably destroyed? In this situation, translocation is the only solution, and although this is still to be considered an absolute last resort, it can provide a valuable opportunity to acquire skills and knowledge, and a chance to bring enthusiasts, practitioners, government agencies and local community members together in a common cause.

This was the case when a population of *Diuris behrii* (Golden Cowslips) was facing certain destruction in central Victoria.

Description, Distribution and Conservation Status

Diuris behrii is a terrestrial orchid that grows up to 50 cm tall, with multiple grass-like leaves emerging in autumn, and between one and four large yellow flowers appearing in late spring. In Victoria, *D. behrii* occurs mostly in grassland remnants along roadsides and on private land in the Goldfields and Western District. It faces a number of threats including roadworks, vehicle disturbance, herbicide and fertiliser application, and trampling or grazing by stock. *Diuris behrii* is currently listed as vulnerable in Victoria (DSE 2005).

Background

The population of *D. behrii* at Taradale was brought to the attention of officers from the Department of Sustainability and Environment (DSE) by local community members when they discovered it was in the path of the new alignment of the Calder Freeway.

In July 2004, a meeting of local community representatives, members of the Australian Native Orchid Society (ANOS), DSE officers and staff from VicRoads (the state roads authority) drafted a plan to translocate the orchids to a suitable site on land adjoining the freeway reserve currently owned by VicRoads. This land was destined to either become a reserve or be sold as freehold with a Trust for Nature covenant. DSE subsequently wrote a formal translocation plan which was submitted to all stakeholders for review before it was finalised.

Salvage

In two separate salvages, in September and October 2004, staff from DSE and VicRoads, ANOS members and local community volunteers removed as many plants as they could find from the site. In September, the leaves were well up and the plants were easy to locate using a grid search technique. By October many of the plants were flowering and easier to find. Plants were removed in blocks of soil, which were then placed in numbered foam boxes, and the gaps between the blocks packed with perlite and loose soil. The soil was quite moist and soft enough to dig with a spade, so excising blocks of soil up to 15 cm deep was not difficult.

The boxes of plants were stored at the home of a central Victorian ANOS member, in a shadehouse provided by VicRoads. It was initially intended that the orchids be re-planted in the winter of 2005, but a suitable site wasn't selected until early in 2006, and so the planting was re-scheduled for August in that year. Meanwhile the orchids were lovingly cared for by their ANOS hosts – regularly watered, weeded and watched. The plants in each numbered box were also carefully counted, both at flowering time, and at re-emergence in autumn, to provide good baseline data from which to assess the eventual success of the translocation.

Site Selection and Preparation

In February 2006, officers from DSE and VicRoads met with members of ANOS and the local community at Taradale to select a site for replanting. The key criteria for site selection were landscape position, slope, aspect, soil type, access, and the absence of weeds.

A site was chosen approximately 700 m east of the salvage site that satisfied all the criteria. The 30 m x 30 m site was subsequently fenced by VicRoads to specifications provided by DSE. Gates were installed on each side of the enclosure to allow easy through access for vehicles with trailers, and to enable the site to be opened for grazing by the resident kangaroos if the native grass became too dense.

The site was marked out into 50 cm x 30 cm plots (approximately the size of the foam boxes). Each plot was identified with a numbered peg, to match the numbered boxes to the plots for on-going monitoring purposes.

Planting Day

The boxes containing the orchids were transported to the site the day before on two large tandem trailers – well tarped to protect the plants from the wind during the 80 km trip. On the following morning a team consisting of DSE and VicRoads staff, ANOS members, and local community

volunteers, arrived at the site, complete with wheelbarrows, spades and trowels, and were quickly allocated various tasks. The first job was to place each numbered box next to its corresponding numbered plot.

Once the first few boxes were placed, work started on digging the holes to receive the blocks of soil containing the orchids. As the foam boxes and the depth of soil in each varied slightly in size, each hole had to be individually 'tailored' to fit.

Excavated soil was removed by wheelbarrow crews, leaving some loose soil behind for packing around the soil blocks. After the soil blocks were placed in the holes, the gaps were filled with soil, and approximately 8 litres of water applied to each plot with a watering can. No follow-up watering was needed due to adequate rainfall in the following months.

Monitoring

The first monitoring results of the site in October 2006, at flowering time, came as a bit of a shock, as many of the plants had succumbed to a succession of heavy frosts in the previous weeks. The total number of flowering plants was 250 out of about 660 plants. No natural pollination was observed, possibly due to frost damage sustained by many of the flowers.

Top: Laying out boxes containing the orchids. Photo: Deanna Marshall
Bottom: Site at completion of translocation. Photo: Geoff Nevill

A typical plot in October 2007, this one with 100% survival. Photo: Geoff Nevill

In October 2007 however, we were greeted by row upon row of nodding yellow flowers, and the count was 647 flowering plants, indicating at least a 98% survival rate for the translocation. Many of the flowers had been naturally pollinated, another good indicator of success and a promise of potential recruitment. Needless to say, the local community volunteers were very pleased with the results of their efforts.

In the short-term this appears to be a very good outcome. However only long-term monitoring over the next ten years will give a true indication of whether this translocation can be judged a success.

Conclusion

These days it is almost inevitable that the priorities of large infrastructure projects will conflict with those of biodiversity conservation. Even so, translocation of a threatened species should always be seen as an absolute last resort. In this instance, apart from the rescue of the orchids, additional benefits included the opportunity to work with the local community, and a chance to develop techniques and learn skills that will be valuable in the future. We hope that salvages of this kind will not become a common occurrence, but when it does happen, we want to be well-prepared, with the best possible chance of a successful outcome.

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The Cape York 'Rare and Threatened Plants Project'

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Cape York is Australia's largest wilderness area, and home to a known 379 rare and threatened plant species. Many are found nowhere else in the world, or only have similar subspecies in New Guinea and the Daintree. There are doubtless many more plants that await discovery, and many that have been only briefly described.

Together with the Daintree region which borders the southern areas of the Cape, there are many hundreds of special plants that need some form of management to ensure their survival in the far northern areas of Queensland. The 'Cape York Rare and Threatened Plants Project' aims to help protect these species, both in the wild and by planting into the Cooktown Botanic Gardens. The Gardens is also Heritage listed, so having a representation of the rarest plants from Cape York will add to its prestige.

It is hoped that adding the plants to the Gardens will provide a store of them for the future. If any species become extinct in the wild, propagation material could be drawn from the plants in the Gardens, including from a store of seeds that will be kept there like a biological bank for the future.

Expert advice has been gained from one of North Queensland's most experienced botanists, Gary Sankowsky. He has developed a method for obtaining seedlings from the wild, and this method will be employed during the project. Young seedlings will be taken and grown in mist houses until they take root.

The Cooktown Botanic Gardens Depot will also be redeveloped into a modern Horticultural and Botanic Centre, with labs and nursery facilities for growing plants and storing seed. A Herbarium will also be developed to record as much information as possible about the plants of the Cape.

In the wild, the GPS location of the plants will be recorded and a database developed to help understand exactly where the plants grow. The rare and threatened species grown in the Botanic Gardens nursery will also be replanted into disturbed areas throughout the Cape where they are known to have grown before, in revegetation projects. This will help ensure sufficient numbers in the wild for the survival of each plant species. There are also plans, later in the project, to help protect plants in the wild by fencing off areas from feral pigs and wild cattle, and to use various techniques to control weeds that may also be threatening the species.

Community Involvement

In southern areas of the Cape, the Rossville Community Association, just south of Cooktown, has pledged its support by providing a nursery for propagation of plants from the areas surrounding Cedar Bay National Park. Sandy Lloyd, the Association leader, has a permit to propagate protected plants, and together with local landholders, will work to grow many of the rare and threatened species from around Cedar Bay.

Indigenous people have also expressed their interest, with the Lockhart River Land and Sea Centre discussing the proposal for their involvement in the Iron Range, Pascoe River and Macilwraith Range areas, where many of the rarest plants grow. In the Mossman region in the south of the Daintree rainforest, the Goobidi Bamanga indigenous organisation has also pledged its support. They have constructed their own nursery and will be attempting to propagate the rarest plants from their area.

It is hoped that areas north of Cooktown, around Laura and Hopevale, will also be involved, and discussions with the indigenous people of those areas will begin soon. There are many unique sandy soil based environments just to the north of Cooktown, again with many rare and threatened plants.

Mount Tozer, in Iron Range National Park, Cape York, Far North Queensland. Here heath, swamp, rainforest and woodland grow in a mosaic which creates a perfect environment for a great variety of unique and rare tropical plants. Photo: Daniel Collins

The "Coloured Sands" just north of Cooktown. With such a variety of unique environments on Cape York, there is a wealth of plants that are very specific and restricted in their distribution, which often leads to them being registered as threatened. Photo: Daniel Collins

The Cook Shire Council has confirmed it will allocate $25,000 to start the project. An application for another $27,500 has been made through the Cape York Marine and Coastal Environment Advisory Group.

To help provide for the correct environment in the Cooktown Botanic Gardens, new garden areas are being constructed. Some will provide for wetter rainforest conditions, some will be more open drier environments, and others will represent the sand country found in several areas of the Cape.

Support has also come from many relevant native plant organisations, including the Society for Growing Australian Plants. Together with local community and indigenous groups expressing their interest, it is hoped the project will allow for widespread participation from North Queensland's plant enthusiasts.

Benefits for Conservation

The project aims to achieve a store of plants for the future in the Botanic Gardens, a store of seeds in the Gardens' new Horticulture and Botanic Centre, a GPS database of the locations and distribution of the plants throughout the Cape, a reserve of nursery plants ready to be planted out in revegetation projects throughout the Cape, and on-ground works including protection from feral animals and weeds. It is hoped this multi-pronged approach to conservation will be the project's key to success.

Development of conservation technologies for Australia's rainforest and tropical native fruits

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Australia's Crop Wild Relatives

Crop wild relatives are native taxa that are close relatives of commercial crop plants and represent the wider genetic diversity of the crop gene pool. They are a valuable source of functional traits (e.g. disease resistance, flood tolerance and medicinal properties) for improvement of food, forestry and medicines. Thus, continuing access to the existing crop wild diversity is important. Australia has crop wild relatives of many species economically important worldwide. Some of the nationally and internationally significant crop wild relatives and bush foods of Australia are listed in Table 1. They include rainforest genera that contain commercially cultivated species (e.g. *Macadamia integrifolia*), crop wild relatives of commercially important species (e.g. *Macadamia* spp., *Citrus* spp., *Musa* spp.) or bush foods of local importance (e.g. *Citrus australasica*, Finger Lime; *Davidsonia pruriens*, Davidson's Plum) (Fig. 1). Table 1 also provides a summary of the percentage of species under threat for their genus in Queensland.

Vulnerability of Rainforests to Climate Change

One of the key risks of projected climate change is its effect on Australian rainforests, which are one of five natural systems predicted to be vulnerable to damage (Hennessy *et al.* 2007). Climate change is predicted to interact with other threats, such as weeds and habitat fragmentation, in some of the most vulnerable environments including the Wet Tropics. For example, relative to 1990, about a 50% decrease in montane tropical rainforest area in northern Australia is predicted by 2020 (Hennessy *et al.* 2007).

Conservation of Rainforest Seeds

The seed of many species can be routinely stored *ex situ* in seed banks using standard desiccation (5% moisture content) and freezing (-20°C) protocols; such species have 'orthodox' seeds. However, not all species are amenable to these procedures (i.e. they have 'non-orthodox' seeds) and require the development of alternative conservation technologies, particularly *in vitro* and approaches using very low temperatures (i.e. cryopreservation), before long-term *ex situ* conservation can be achieved (Pritchard 2004; Ashmore *et al.* 2007). Conservation of these species is thus currently restricted to *in situ* approaches or field collections *ex situ*, making them particularly vulnerable to loss.

The number of Australian species with non-orthodox seeds is unknown. Recent studies have estimated that worldwide up to 30% of flowering plants or >80,000 species may have desiccation sensitive seeds and thus not be amenable to standard seed banking protocols. Tweddle *et al.* (2003) estimate that 48% of species in non-pioneer evergreen rainforest world-wide will have seeds that display desiccation sensitivity.

Target 8 of the Global Strategy for Plant Conservation is to achieve "60 per cent of threatened plant species in

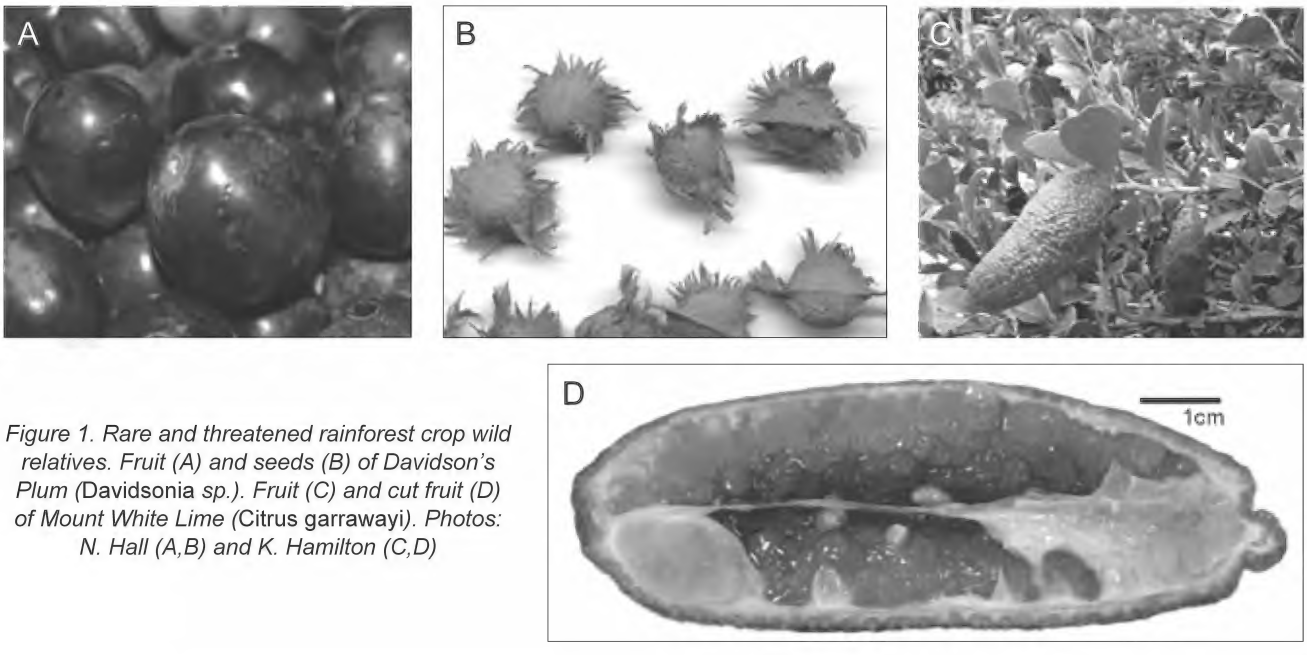

*Figure 1. Rare and threatened rainforest crop wild relatives. Fruit (A) and seeds (B) of Davidson's Plum (*Davidsonia *sp.). Fruit (C) and cut fruit (D) of Mount White Lime (*Citrus garrawayi*). Photos: N. Hall (A,B) and K. Hamilton (C,D)*

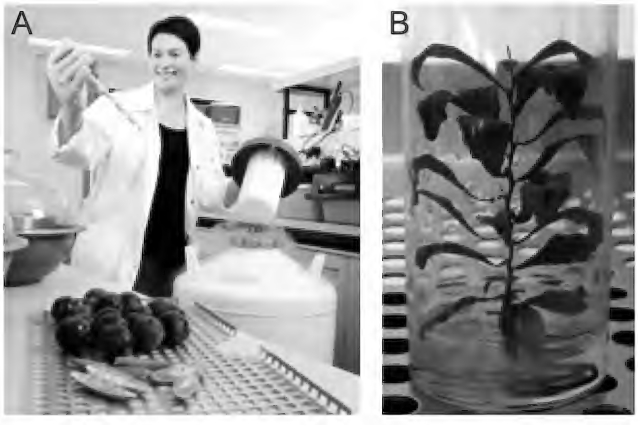

*Figure 2. A: Storage of plant material by cryopreservation in liquid nitrogen (-196ºC). B: In vitro storage and propagation of the Vulnerable Russell River Lime (*Citrus inodora*). Photos: S. Ashmore (A) and K. Hamilton (B)*

accessible *ex situ* collections …" giving clear recognition for the importance of *ex situ* conservation to support *in situ* initiatives. Target 8 also states the need for "additional resources, technology development and transfer, especially for species with recalcitrant seeds" (i.e. non-orthodox seeds). Thus, there is an urgent need to develop technologies (e.g. cryopreservation, Fig. 2) to conserve the diversity of Australia's rainforest species. Many of the rare and threatened crop wild relative species in the genera listed in Table 1 are of rainforest and/or tropical origin with likely non-orthodox seeds.

Case Study

International and national partnerships have been established to develop alternative technologies for the conservation of Australian species with non-orthodox seeds. These include the Millennium Seed Bank Project (Royal Botanic Gardens Kew, UK), the Queensland Seeds for Life project and the Rainforest Seed project (Botanic Gardens Trust, Mount Annan, NSW).

An example is the development of conservation technologies for the rare *Citrus garrawayi* (Mount White Lime), an edible lime with unique fruits (Fig. 1C, 1D) that grows in the monsoon forests and rainforests of Cape York Peninsula, Queensland. The *ex situ* storage and use of its seeds are hindered by seed availability (i.e. limited access and supply), quality (e.g. maturity) and some desiccation sensitivity. However seeds can be stored by cryopreservation and also be coupled to a straight forward *in vitro* propagation system (Hamilton *et. al.* 2008). This example illustrates the use of conservation technologies to create *ex situ* storage options and facilitate propagation for utilisation of plant material (e.g. for horticultural and restoration purposes).

The Future

There is growing recognition of the national and international importance of crop wild relatives as a vital source of genetic diversity, and of the increasing threat to these from habitat destruction and climate change. Thus there is an urgent need to develop alternative *ex situ* conservation technologies, especially for rainforest fruits and crop wild relatives which currently cannot be stored by standard seed banking methods. It is imperative to (i) develop secure conservation collections and (ii) develop conservation technologies such as cryopreservation for the *ex situ* conservation of non-orthodox seeded species. This will contribute to Australia's commitment to the Global Strategy for Plant Conservation and the International Treaty on Crop Genetic Resources.

Table 1. Some Queensland genera with likely non-orthodox seed and of socio-economic importance as Crop Wild Relatives (CWR) or Bush Foods (BF)[1], with numbers and percentages of species in each genus under conservation threat[2].

Genus	Common name	Category	Fraction (%) of species in genus under threat
Alpinia	Native Ginger	CWR	1/5 (20%)
Capparis	Australian Caper	CWR	2/22 (9%)
Citrus	Wild Limes	CWR/BF	2/5 (40%)
Elaeocarpus	Quandong	BF	
Davidsonia	Davidson's plum	BF	1/3 (33%)
Diploglottis	Native Tamarind	BF	3/10 (30%)
Garcinia	Wild Mangosteen	CWR	1/6 (17%)
Macadamia	Macadamia	CWR/BF	6/7 (86%)
Musa	Wild Banana	CWR/BF	2/3 (66%)
Myristica	Australian Nutmeg	CWR/BF	0/2 (0%)
Passiflora	Wild Passionfruit	CWR/BF	0/1 (0%)
Piper	Wild Pepper	CWR/BF	1/7 (14%)
Syzygium	Lilly Pilly, Rose Apple	BF	10/49 (20%)

[1]Table modified from Ashmore *et al.* (2007)
[2]From Henderson (2002)

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WA workshops report: 'After the Fence'

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The Australian Network for Plant Conservation ran two successful workshops, *After the Fence,* in the Western Australian Wheatbelt towns of Northam and Moora on 17-18 and 27-28 March, 2008. The workshops were done in partnership with WWF-Australia, the Northern Agricultural Catchments Council, the Avon Catchment Council and the Australian Government Envirofund.

Based on the successful format of the ANPC's previous rehabilitation workshops, the March 2008 workshops focused on the management needs of Wheatbelt woodlands after a fence has been erected. Western Australia's Wheatbelt, like many other agricultural landscapes in Australia, has seen significant investment in recent years in fencing native vegetation to exclude grazing by domestic stock. While fencing is the first and most important step in ensuring the long-term future of native vegetation in grazed landscapes, it is frequently the first and last step in native vegetation management in these areas.

The *After the Fence* workshops attracted 67 participants, presenters and volunteers. All involved found the workshops valuable and interesting. The networking component of the workshops was judged as useful as the content of presentations and field trips.

Workshop participants included farmers, community group members, Natural Resource Management Officers from throughout the Wheatbelt, WWF Project Officers, and staff from the WA Department of Main Roads, the Water Corporation, the Department of Environment and Conservation and CSIRO. The common factor linking all participants and presenters was an interest in the on-ground management of Wheatbelt woodlands.

A new feature of the WA workshops was the inclusion of a group dinner and an after-dinner speaker. At the Northam workshop Patrick Smith from CSIRO spoke to the group about the reality of balancing production and conservation, while at the Moora workshop, Dejan Stojanovic from Birds Australia entertained the group with photos, stories and bird calls in his presentation on using Carnaby's Black Cockatoos as a flagship species for biodiversity conservation in south-west Australia.

A flora identification session on the afternoon of the first day of each workshop was also popular, with participants (and presenters!) learning how to identify local woodland eucalypts and wattles using the latest interactive keys, and the techniques and importance of proper plant collection. Farmers, researchers and community group members worked together to nut out botanical terms and tricky morphologies and had a great time doing it – some refusing to stop until they'd worked their specimens out!

The second day of each workshop was largely taken up by a field trip. Two sites of varying condition and vegetation type were visited on each trip. At each site participants had worksheets to complete on assessing the health of the woodlands they were visiting, deciding upon management actions and developing monitoring plans. Particularly rewarding for the organisers was the answer to the last question on the worksheet, viz. whether the participant's opinion of the health and management of the woodlands changed between their first sight of the remnants and when they had completed the worksheets. Almost all participants found that working systematically through indicators of health and management actions helped them to find conservation value in woodlands they thought were in poor condition, and to realise that woodlands they thought were in great condition could still benefit and improve with management.

All in all, the workshops successfully achieved their aims. The organisers are grateful for the enthusiastic participation of all who attended, particularly the presenters who gave up their time to develop relevant presentations and be involved.

Moora workshop participants at a majestic Salmon Gum woodland site. Photo: Helena Mills/WWF-Australia

Report from New Zealand Plant Conservation Network

Bec Stanley

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A New Sponsor

Phytomed Medicinal Herbs Ltd is a new sponsor of the NZPCN. Phytomed is a NZ-owned company which produces herbal medicine products for qualified healthcare practitioners. It manufactures the Kiwiherb® range, which uses some NZ native herbs and from which the NZPCN will receive proceeds. The mission of NZPCN (that no indigenous species of plant will become extinct nor be placed at risk of extinction as a result of human action or indifference, and that the rich and unique plant life of New Zealand will be recognized, cherished and restored) appealed to Phytomed and the company hopes its assistance will help to bring this vision into reality.

Digitising Botanical Reports

NZPCN has successfully applied for funding to digitise all the back issues of the regional botanical society journals. In NZ there are several regional botanical societies that each produce journals full of valuable botanical information, such as plant lists and locations, descriptions of habitats and threats. Many of these journals have small print runs and are only accessible in their local regions. It will be a fantastic national resource to have these stored electronically in a publicly accessible place – who knows what new knowledge will come to light with this data being available.

What's New on the Website

Our ever-popular website has a few new features. Distribution maps for 500 threatened and uncommon indigenous plant species have been added and are available to Network members only. Another member-only feature is the addition of some high resolution images to help members with identification. A new 'Frequently Asked Questions' page has been added as the Network receives many queries each week from Network members and the public. Some of the more commonly asked questions have now been answered.

New Zealand Plant Conservation Network Conference

The Network conference will be held Friday 8th – Sunday 10th of August at Te Papa in Wellington. More information can be found at http://www.nzpcn.org.nz/news_events/conference.asp.

Research Roundup

Austral Ecology (2008), volume 33(4): special issue on **cyclone impact on ecology and vegetation**; includes about 20 articles.

Barbour, R.C., Otahal, Y., Vaillancourt, R.E. and Potts, B.M. (2008). **Assessing the risk of pollen-mediated gene flow from exotic *Eucalyptus globulus* plantations into native eucalypt populations of Australia**. *Biological Conservation* 141(4): 896-907.

Barrett, S. and Cochrane, A. (2007). **Population demography and seed bank dynamics of the threatened obligate seeding shrub *Grevillea maxwellii* McGill (Proteaceae)**. *Journal of the Royal Society of Western Australia* 90: 165-174.

Cahill, D.M., Rookes, J.E., Wilson, B.A., Gibson, L. and McDougall, K.L. (2008). **Turner Review No. 17. *Phytophthora cinnamomi* and Australia's biodiversity: impacts, predictions and progress towards control**. *Australian Journal of Botany* 56(4): 279-310.

Commander, L.E., Merritt, D.J., Rokich, D.P., Flematti, G.R. and Dixon, K.W. (2008). **Seed germination of *Solanum* spp. (Solanaceae) for use in rehabilitation and commercial industries**. *Australian Journal of Botany* 56(4): 333-341.

Davis, J. and Brock, M. (2008). **Detecting unacceptable change in the ecological character of Ramsar wetlands**. *Ecological Management & Restoration* 9(1): 26-32.

Research Roundup (continued)

Eaton, L.C. and Kleindorfer, S. (2008). **Germination in two Australian species of Frankenia L., *F. serpyllifolia* Lindl. and *F. foliosa* J.M.Black (Frankeniaceae) – effects of seed mass, seed age, and temperature**. *Transactions of the Royal Society of South Australia Inc.* 132(1): 18-28.

Fiedler, A.K., Landis, D.A. and Wratten, S.D. (2008). **Maximizing ecosystem services from conservation biological control: the role of habitat management**. *Biological Control* 45(2): 254-271.

Lawes, R.A. and Wallace, J.F. (2008). **Monitoring an invasive perennial at the landscape scale with remote sensing**. *Ecological Management & Restoration* 9(1): 53-59.

Menges, E.S. (2008). **Turner Review No. 16. Restoration demography and genetics of plants: when is a translocation successful?** *Australian Journal of Botany* 56(3): 187-196.

Rossetto, M. (2008). **From populations to communities: understanding changes in rainforest diversity through the integration of molecular, ecological and environmental data**. *Telopea* 12(1): 47-58.

Sampson, J.F. and Byrne, M. (2008). **Outcrossing between an agroforestry plantation and remnant native populations of *Eucalyptus loxophleba***. *Molecular Ecology* 17(11): 2769-2781.

Spooner, P.G. and Briggs, S.V. (2008). **Woodlands on farms in southern New South Wales: a longer-term assessment of vegetation changes after fencing**. *Ecological Management & Restoration* 9(1): 33-41.

Terry, I., Forster, P.I., Moore, C.J., Roemer, R.B. and Machin, P.J. (2008). **Demographics, pollination syndrome and conservation status of *Macrozamia platyrhachis* (Zamiaceae), a geographically restricted Queensland cycad**. *Australian Journal of Botany* 56(4): 321-322.

Information Resources and Useful Websites

Taking botanical photographs

Garry Sankowsky
http://www.anbg.gov.au/asbs/newsletter/newsletter-pdf/07-dec-133.pdf.

Well-known plant photographer Garry Sankowsky has published an article in the *Australian Systematic Botany Society Newsletter* (2007) volume 133, pages 23-28 with information on how to take botanical photos. He discusses equipment such as camera type, lenses, how to store digital images, and provides useful tips on how to edit digital images.

How to collect and preserve plant specimens

http://www.anbg.gov.au/cpbr/herbarium/collecting/index.html
http://www.epa.qld.gov.au/publications?id=1811

Correctly identifying plants is fundamental to plant conservation activities. If you're not sure how to go about this, the above two web sites provide help. The first, from the Centre for Plant Biodiversity Research (CPBR), Canberra provides on-line guidelines, while the second, from the Queensland Herbarium, Brisbane provides a manual that can be down-loaded as a pdf document. Both resources contain illustrated procedures for collecting plants and the equipment needed (including a collecting permit), and the types of information that should be collected to make a herbarium specimen that has lasting scientific value. The CPBR site also contains sections on how to handle "difficult" plants, such as ferns, cycads, aquatic plants, eucalypts and daisies, to make sure you have the right parts to allow identification.

Conferences and Workshops

Craft ACT
Baselines: colonisation and conservation

15 August 2008
Willeroo, Collector Road (near Tarago), NSW

A public forum designed to initiate community exchange about issues of preservation and care of the land, and the role of the arts as an advocate for change and renewal. The day will feature discussions about new land practices including holistic grazing, and local plant regeneration and indigenous practices. Artists Christine James and Beth Hatton will talk about their exhibition *Baseline: Remnant Grassland at Weereewa/Lake George* and Paull McKee and Jennifer Lamb will examine the role of arts in bringing together new ideas.

Further information: diana.hare@craftact.org.au

Coast to Coast Conference 2008
Coast to Coast Collaboration: Crossing Boundaries

18-22 August 2008
Darwin Convention Centre, Darwin, NT

Coast to Coast 2008 is Australia's biennial national coastal conference. It will focus debate, discussion and learning across the full range of coastal and marine issues, at the international, national, state, regional and local levels.

Themes include: coastal climate change and disaster management; coastal planning for population change; monitoring, mitigation and management of land and marine-based pollution; coastal mining and offshore oil-gas developments; coastal-marine biodiversity and conservation management; coastal ecosystems, people and the future within the Arafura Timor Seas; community engagement, capacity-building and training.

Further information: https://www.coast2coast.org.au/

Volunteering Australia 12th National Conference on Volunteering

Catch the New Waves

3-5 September 2008
Radisson Resort, Gold Coast, Qld

The conference will explore current and emerging trends in volunteering using three subthemes: the shift in the way people are volunteering, flexibility in management, and the changing demographics of volunteering.

The keynote speakers are Bruno Ayres, Chief Networking Officer for the V2V Network (Volunteer-to-Volunteer), and Tim Costello, CEO of World Vision.

Further information: http://www.volunteeringaustralia.org/html/s01_home/home.asp

Botanic Gardens of Australia and New Zealand (BGANZ) NSW Conference 2008

Accentuate the Positive

6-9 September 2008
Eurobodalla Regional Botanic Gardens, south of Batemans Bay, NSW

The conference theme *Accentuate the Positive* has been chosen to illustrate the BGANZ aim of encouraging botanic gardens staff to share the secrets of their successes. The program will allow for presentations each morning from gardens workers (whether paid or unpaid), to be followed each afternoon by workshops and seminars on the same topics with expert and practitioner input.

Further information: http://www.erbg.org.au/visitor/links.html

2008 Queensland Landcare Conference
Infinity: Sustainability by Design

21-24 September 2008
Monto, Qld

The conference, which is hosted by North Burnett Landcare Group, will have four streams which focus on sustainability: landscapes, lifestyles, livelihoods and landspeak. There are 45 speakers, seven field trips and 22 concurrent workshops to choose from.

Further information: http://www.landcare.org.au/Conference.htm

Australian Systematic Botany Society Inc. Conference
Systematics and evolution in a changing environment

28 September – 3 October 2008
University of Adelaide, Adelaide, SA

Subject areas include evolution in a changing climate (e.g. aridity, salinisation); communicating and teaching systematics; speciation, co-evolution and adaptive strategies; systematics and evolution of weeds; non-vascular groups; and new approaches and technologies.

Further information: http://www.anbg.gov.au/asbs/conferences/2008-adelaide/index.html

Conferences and Workshops (continued)

Wimmera Growers of Australian Plants Inc. FJC Rogers Seminar – Eremophilas 2008

4-5 October 2008
Horsham College Assembly Hall, Horsham, Vic

This seminar is for enthusiasts of Australian plants, and all gardeners who want to have an attractive garden with low water use. The keynote speaker is Dr Bob Chinnock, Senior Botanist, South Australian Herbarium, who recently published his revision of the genus *Eremophila* and allied genera. Other speakers are Norma Boschen, who has 30 years experience in growing eremophilas, and Dr Enzo Palombo, who will talk on anti-microbial properties of *Eremophila* extracts. A field excursion will include visits to three gardens predominantly planted with eremophilas and the Wail Arboretum.

Further information: http://home.vicnet.net.au/~wgapinc/

Veg Futures 08

20–23 October 2008
Toowoomba, Qld

Greening Australia and Land & Water Australia invite you to *Veg Futures 2008* – a comprehensive, practical conference about the nation's most pressing challenges for vegetation management in regional and peri-urban landscapes.

Veg Futures 08 tackles the big questions around vegetation management with a focus on biodiversity, water quality and landscape resilience in the face of climate change. The conference will also explore the policy environment for vegetation management, the potential role of carbon markets, the latest techniques for revegetation as well as specialist sessions on the role of art in the environment and communication for natural resource management practitioners.

Further information: http://www.greeningaustralia.org.au/resources/veg-futures-08

Ecological Society of Australia, 33rd Annual Conference Interactions in science, Interactions in nature

1-5 December 2008
University of Sydney, NSW

Symposium topics include insect-plant interactions; plant-pollinator interactions; ecological responses to fire; marine and terrestrial invasions, taxonomic impediments, impacts on native ecosystems and control measures; and native seeds – germinating science for revegetation success. The conference includes a field trip (four options provided), four concurrent workshops and a post-conference tour.

Further information: http://www.ecolsoc.org.au/2008SydneyConference.htm

Advance notice of other conferences

GREENHOUSE 2009: Climate Change & Resources, 23-26 March 2009, Burswood Convention Centre, Perth, Western Australia. Further information: http://www.greenhouse2009.com/

Ecology in a Changing Climate: Two Hemispheres – One Globe. 10th International Congress of Ecology, INTECOL, 16-21 August 2009, Brisbane, Queensland. Hosted by The Ecological Society of Australia and The New Zealand Ecological Society. Further information: http://www.intecol10.org

Making Change in a Changing World. 19th World Conference on Ecological Restoration, Society for Ecological Restoration International (SERI), 23-27 August 2009, Perth, WA. Further information: http://www.seri2009.com.au/pages/home.html

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GUIDELINES FOR THE TRANSLOCATION OF THREATENED PLANTS IN AUSTRALIA (Second edition)

L. Vallee, T. Hogbin, L. Monks, B. Makinson, M. Matthes, and M. Rossetto. 2004.
The Australian Network for Plant Conservation, Canberra Australia, 80 pages

'one of the most comprehensive reviews of plant translocation ever published'

Mike Maunder
(Deputy Chair of the IUCN-SSC Reintroduction Specialist Group, 2004)

Chapter 1: introduction to translocation, terminology, why some translocations fail

Chapter 2: guidelines to assess whether translocation is appropriate or necessary

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Chapter 7: post-translocation monitoring, evaluation andongoing management

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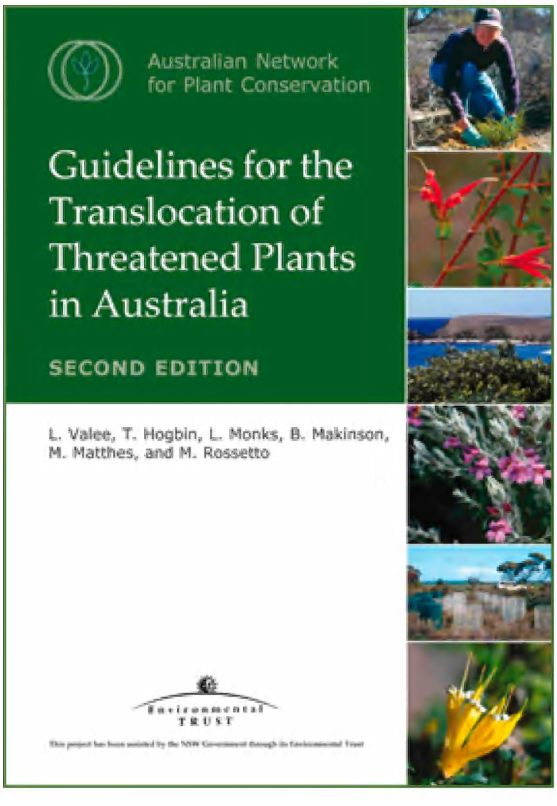

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